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EDITED BY MAJOR W. A. HARRISON,
SECRETARY, R.E. INSTITUTE.

PAPER 3.

VOLUME 3

THE GROWTH OF THE OFFENSIVE IN FORTIFICATION.

BY

MAJOR J. C. MATHESON, R.E.

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"THE artificial defences of the lines altogether present a most favourable example of the engineer's art in furtherance of, but invariably subservient to tactics, creating pivots and supports but never a tie or restraint on field movements."

COLONEL JONES' *Memoranda on the Lines of Torres Vedras.*

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NOTE.

My thanks are due to Colonel J. E. Capper, C.B., and Colonel B. R. Ward for advice in the arrangement of this pamphlet.

J.C.M.

THE GROWTH OF THE OFFENSIVE IN FORTIFICATION.

INTRODUCTION.

THE following pages represent an attempt to put forward very briefly the present state of military thought as regards the design of fortresses.

In order to do this clearly the history of the subject must be rapidly passed in review, for our present conceptions are the outcome of the thoughts of previous generations of military thinkers.

The British Army is trained to fight according to modern civilized methods. A complete training in these methods includes fortress warfare, but our insular position and national policy have tended somewhat to obscure the necessity for our study of this branch of the military art. The recent struggle in the Far East has however re-focussed a considerable amount of attention upon the attack and defence of fortresses even among ourselves, as is evinced by the military literature of the day and the prevalence of siege manœuvres. We also possess units of artillery and engineers specially trained for siege work. It is therefore thought that a brief presentment of the existing military opinion on the subject of the design of fortresses may be not without utility.

Fortification is a progressive art and this is clearly shown by the study of history, improvements in weapons being the main cause of changes in fortification.

For various reasons, however, fortifications respond very slowly to this onward movement. In the first place works of fortification are so costly that continual changes are out of the question.

Secondly, too much attention has in all ages been directed to the latest invention or improvement in war material. The tendency of human nature is always to magnify these far beyond their real value. This causes the prevalence of a distorted view of the state of things, under the influence of which hasty changes are made which prevent progress, or even cause retrograde steps to be taken.

Thus it is often stated that some new invention is going to

"revolutionize warfare." It may be an explosive, an automatic gun, a torpedo, an airship or what not, but the various changes in the conduct of military operations in the last generation can hardly be called "revolutions" in spite of the wealth of inventive genius which has been expended upon the improvement of war material. It is true that in this mechanical age the rate of progress has increased, but history has shown the mistake of looking upon everything as obsolete simply because it is a few years old. The bayonet was still of use in Manchuria in 1904, and the sap, which had nominally been obsolete for many years, enabled the Japanese infantry to capture Port Arthur.

It is not that new inventions do not have an effect on warfare, naturally they do. But before that effect becomes overwhelming the wit of man has been able to devise something which will once more put both sides on a practical equality.

Thirdly, in the same way as new inventions are lauded indiscriminately, too much stress is always laid on the details and incidents of the latest campaign, and this has its influence in causing ill-advised changes more perhaps in the realm of fortification than in any other. Because troops are successful in a certain fortified position, it is at once assumed that some feature of their works must have possessed a peculiar virtue and should be generally adopted. The "undercut" Boer trench is a case in point.

Lastly, the extreme difficulty of determining the true causes of success or failure in fortress warfare tends to make progress in the art of fortification very slow. The truth is that while we can criticize, with a fair amount of judgment, the fortifications of the past, comparison is excessively difficult during and immediately after a campaign. It is only when time has passed, and all the factors which go to make up success or failure can be properly weighed, that a true judgment can be arrived at and the good points of defensive works noted for the benefit of futurity. Amongst these factors the human one is the most important of all. Fortified positions, when tried by the test of war, will differ not only in the details of their construction and the ground on which they are laid out, but there will be differences in the fighting qualities of their commanders and garrisons, in their state of readiness and in the strength and energy of their besiegers. Whatever be the final issue—early capture, long resistance, or successful holding out—who is gifted enough to assign at once the credit or discredit to the proper quarter, the commander, the garrison, the forts, or the enemy, or to apportion the due amount of praise or blame to each ?

Changes in the art of fortification have been so slow that in any review of its history it is necessary to regard it—as an artist does his landscape when he wishes to determine the high lights and deep shadows—with half-closed eyes. Viewed thus the details are un-

noticed and only the main features stand out. The most prominent of these is the way in which fortification has passed more and more under the influence of the "offensive." In early days the engineer regarded his works principally as a protection to his own troops and as a physical obstacle to the enemy. The weapons of the period were so weak and short-ranging that their use was almost entirely confined to preventing the enemy from destroying or piercing this obstacle. This is emphasized by the inaccessible sites chosen for many old fortresses.

At the present time the great feature of fortifications is that they are designed and sited so that they shall give full play to the weapons of the defenders, the obstacle having become of secondary importance.

This change has been wrought by the difference in the nature of the weapons in use at the two periods. Weapons affect defensive works in two ways. The works must be so designed that the weapons of the defenders shall have every facility possible for their use, while at the same time they must protect the said defenders from the effects of such weapons as will probably be used by the enemy.

In the action of all arms there is a constant struggle between the influence of the "offensive" and the "defensive" point of view. The natural desire is to deal destruction to the enemy at a minimum of risk to oneself and the problem is to find out to what extent the power of taking the offensive must be sacrificed to the necessity of keeping one's own losses within due bounds.

Two examples will illustrate this constant struggle of ideas :—

Thus in an infantry attack, if men could carry a bullet-proof shield, losses would undoubtedly be reduced very greatly ; but the advance would be slow, and manœuvring would be rendered impossible, so that the idea cannot be entertained under present conditions of field warfare. Experience having proved that attacks can be made without the use of shields, this use would entail too great a sacrifice of the offensive to the defensive.

Secondly, owing to the accuracy of modern rifles it has become indispensable at close quarters to provide head cover for fire trenches in fortress warfare. Viewed from the offensive standpoint this is objectionable. Head cover restricts the free use of the rifle, but, having been proved necessary in actual warfare, a portion of the offensive power must in this case be sacrificed to the defensive.

In trying to solve the problem of how to obtain the maximum amount of offensive power with the maximum amount of defence, the only guidance which can be given is a very general one and that is, to do everything to further the offensive idea, and, where the two clash, only to make sacrifices to the defensive when it has been proved that such sacrifices are absolutely necessary. This idea has been tersely expressed by a German writer "Zuerst Wirkung und dann Deckung."

SECTION I.

The progress of fortification from the Middle Ages onwards may be divided roughly into three periods :—

(I.). Prior to the introduction of artillery.
(II.). From the introduction of artillery to about the middle of the 19th century, when the great advances in mechanical science were beginning to have their effect in the world of weapons.
(III.). From that time until the present day.

It must not be imagined however that exact dates can be assigned as the limits of any of these periods, as the progress from one to the other was of a very slow order, and what we now regard as a step in advance was only evolved after many modifications.

FIRST PERIOD.

Before the introduction of artillery, fortification was almost wholly under the influence of the defensive. This would naturally follow from the character of the weapons in use at the time. Missile-throwing weapons were very weak and short-ranging, and the engineer found protection by making lofty walls round the object of defence. These walls were furnished at intervals with towers, which do not appear to have been primarily considered as organs for flanking, but to have been introduced to give structural strength to the perimeter of the wall, to afford quarters for the garrison, and to form rallying posts in the event of the wall being pierced. It is true that a certain amount of flanking fire could be delivered along the curtain wall, but the round trace of most of the towers was ill-adapted for this and the slight projection of the towers from the wall rendered the amount of fire possible very small. The whole length of the wall was notched for the use of weapons, but in the event of attack these notches were not relied on altogether, as it was customary to construct overhanging wooden galleries in front of the notched parapet wall. These galleries were furnished with frontal loopholes and holes in the floor, from which to discharge missiles on the enemy while the latter was attempting to damage the foot of the wall. Openings in the wall to receive the beams on which these galleries or "hoardings" rested, were usually formed when the walls were built. These may still be seen at the top of the keep of Rochester Castle. At Rouen an old

tower (Tour de Jeanne d'Arc), dating from this period, has in modern days been fixed with "hoardings."

In course of time the wooden hoardings were replaced by permanent stonework and the overhanging galleries, now called "machicoulis," became an invariable part of the structure. Innumerable examples of this form of "vertical" defence are still in existence. This recognition of the necessity for making more provision for the use of weapons on the part of the defenders, together with the fact that it became the custom to open loopholes for fire in the lower parts of both towers and curtains, are possibly slight indications of a change in the point of view from which fortification was being regarded.

Plate I shows an example of a fortress of this period in Great Britain, Conway, built about 1284, still in a good state of preservation.

Second Period.

The lofty wall was the universal form of fortification for a very long time. It varied in its details but the main idea was the same in every case. A great change, however, was impending. Weapons propelling missiles by the explosion of gunpowder began to be employed in warfare, in the first half of the 14th century. According to the popular ideas of to-day this invention should have at once "revolutionized warfare," but the slow progress of fortification is exemplified by the fact that the introduction of artillery did not begin to make its effects felt upon the design of fortresses until the 15th century.

The introduction of the new weapon had as usual a twofold effect on fortification. Provision had to be made in the works themselves for its use and, secondly, its effect had to be guarded against. Various plans were adopted in order to allow guns to be used in the defence. By one method embrasures were opened in the lower part of the wall, by another earthen banks were heaped up behind the wall to give sufficient room at the top for the service of the guns, while by a third, exterior works were projected outwards from the base of the wall to receive the guns. This last method proved to be the foundation of the new system of fortification and finally became universal.

These projections, which at first seem to have been employed in front of the gates of fortresses (always looked upon as specially vulnerable points) were given the name of "boulevards" or "bastions." From them not only could the guns fire to the front but the adjacent curtain walls could be flanked as well. *Plate* II., *Fig.* 1, shows one of the earliest bastions.

Protection against the effects of the attacker's artillery was at first obtained by backing the wall with earth. In time it was found that the wall, open as it was to all the blows of the besieger's guns, was

too easily destroyed and the next change was to drop the wall into the ground in order to conceal it. At the same time a ditch was formed in front of the wall so as to preserve the physical obstacle which was still regarded as of paramount importance. The ditch also served to render the use of mines by the besieger more difficult. The general level of the enceinte of a fortress thus became that of the bastions.

It is difficult now to determine the *exact* purpose for which these low level projections in front of the old towers were originally meant. They were certainly artillery positions but it would seem, although the point is not clear, that they were intended primarily for frontal fire and only incidentally for flanking. It was characteristic of the feudal age that each work of fortification should look after itself and not trouble about its neighbours.

As already stated, these bastions were probably first erected in front of the gates of fortresses and then were gradually extended to the front of all the towers. When at this time new fortresses were built, without the old high walls and towers and keeping to the general level of the bastions, the latter were placed at a considerable distance from each other. This was probably due to the surviving influence of the old method, in which the towers were of small diameter compared with the length of the adjoining curtain. The Italians were the pioneers of the new ideas and Verona was the first fortress to which they were applied in anything like fullness. Antwerp is a slightly later example. It was fortified in 1540 by Franz, a German, according to the Italian method. The examples of this period still in existence are exceedingly few, but this country possesses an excellent one in the land front of the town of Berwick-upon-Tweed, which was remodelled by order of Queen Elizabeth, the work being completed about the year 1576. *Plate* II., *Fig. 2*, shows a plan of the fortress as it exists to-day.*

Very soon it became customary to place the bastions closer together,—an example being the citadel of Antwerp which was built about the year 1567 by Paciotto,—and from this time onwards for at least a couple of centuries, the bastioned system of fortification held almost undisputed sway. It is interesting to note that this same citadel of Antwerp held out for 33 days in 1832 against the French and yet after two and a-half centuries it might well have been considered "obsolete!"

It will not be out of place here to examine in some detail this form of fortification which for so many years was practically universal. For the period at which it originated it was undoubtedly a good solution

* The works are religiously preserved by the Municipal Authorities and the reproduction of this plan is due to their permission and that of Capt. F. M. Norman, R.N., who has compiled a description and history of the fortress.

of the fortification problem, as was reasonably to be expected from the men who evolved it. At that time guns and firearms were still of poor quality and it was of the utmost importance that the obstacle should be protected from the efforts of the enemy to surmount or destroy it. The obstacle was the ditch with its counterscarp and escarp walls, and the most effective way to defend it with the least number of men was to pour a flanking fire along it. In order to deliver this fire projections from the line of the wall were necessary and these in their turn required flank fire to protect them. The bastioned trace as it finally took shape allowed a plunging flanking fire to cover practically the whole of the ditch from the parapet itself, thus simplifying command and preventing too great a dispersion of the defending troops. The distant attack was dealt with by artillery fire from the faces of the bastions and from the curtains.

The proportions, dimensions and plans of the bastions and curtains varied according to each engineer's ideas, but one dimension became generally accepted, namely, that the "line of defence," from the flank of one bastion to the salient of the next, should not exceed musket range.

After a time it became customary to make advanced works beyond the main counterscarp. These probably originated in the necessity for giving some protection to the roads of exit from a fortress which invariably issued from a curtain and the first outworks were made opposite the curtains; they were originally called "demi-lunes" and then "ravelins." Gradually the outworks were multiplied.

As time went on the variations in the bastioned system became very numerous, but it does not appear that, when they were subjected to the test of war, any one of them was much more effective than another. They were all variants of the same main idea. Such names as Speckle, Count Maurice, Pagan, Cormontaigne and Vauban may be mentioned but it would be waste of time here to enter into their several designs, which now have interest only for the student of historical detail. The greatest name is that of Vauban, whose fortification experience was unrivalled. Although trammelled by the intricacies of what had now become a complicated trace, Vauban always endeavoured to suit his works to the ground and acted, as he said, on the principle that "one fortified by common sense and not by system." Vauban's chief title to fame was, however, that he reduced to a system the principles involved in the attack of fortresses. By an irony of fate Vauban's "systems" as generally understood refer to the "defensive" rather than to the "offensive" side of his work.

The differences of the so-called systems at this period were often merely in dimensions or angles and it would seem almost as if fortification has become an exercise in geometry. *Plate* III. shows the only existing fortress of this period with outworks in England, namely Brompton, Chatham.

During the time that the bastioned system held sway artillery and firearms were making slow but sure progress in increase of range and accuracy, and very gradually the inability of the system to cope with the weapons of the day became apparent.

The defects may be said to be :—

(*a*). The inability to furnish a good frontal fire.

(*b*). The ease with which the enemy could enfilade the faces and flanks of the bastions, owing to the increased range of artillery.

(*c*). The outworks themselves became a danger to the defence for several reasons. They caused dispersion of the garrison, rendered communication difficult and helped to inculcate the pernicious idea among the defenders that the loss of one line did not matter very much when there were others behind.

(*d*). The difficulty of making counter-attacks owing to the intricate communications and narrow exits.

(*e*). Loss of offensive potential from the fact that the fire from the flanks crossed.

To put it briefly, it may be said that the bastioned system was too much under the influence of the pure defensive to be in touch with the tactical spirit of the time, while the actual protection afforded by it was found to be insufficient. As far back as 1673 the German engineer Rimpler said that, not being agreed with respect to principles, engineers disputed about insignificant details, whilst they neglected the two most important conditions, protection for the garrison from the besiegers' fire and the concentration of a more powerful fire upon the besiegers.

It must not be imagined however that these defects were noticed all at once, and, when they were, it was only after the lapse of years that attempts were made to rectify them. In fact the bastioned system, in a modified form it is true, was applied to Paris as late as 1840 and to the Hilsea Lines at Portsmouth in 1861 (in both cases be it noted without outworks).

Among the multitude of variations of the system, which during the 18th century were brought forward on paper or actually carried out, it is difficult to pick out the points which go to show that the art of fortification was advancing, as it certainly was, in the way of trusting more to offence and less to pure defence. The following may however be cited in support of the argument, namely Carnot's suggestions in 1810 for the increase of artillery fire from a fortress and for better facilities for sorties, also the growing tendency, from the middle of the 18th century onwards, for making detached works in front of the enceinte in order to compel the besieger to commence his works of

attack further out, to provide a better cross-fire over the foreground and to serve as points of support for local counter-attacks. The latter movement is illustrated by the detached ravelins made by Chasseloup at Alessandria in 1800, which were 100 yards in front of the body of the place, and, as one example of many, by the lunettes in advance of Strassburg, which played a part in the siege of 1870. These detached works must not be confounded with the old successive lines of the enceinte. It is true that they were outworks, but they served a different purpose to the old ravelins and hornworks and were the embryo of modern fortification.

On the other hand, as an example of the slow progress of the art, an instance may be given here of the unpractical view of fortification still prevailing at this period. In 1815 British Commissioners were sent to the Netherlands to report upon the fortresses. In accordance with the custom of the time they classified them according to the number of the defensive lines of which they were composed, stating that this place could hold out for 30 days of open trenches while that could stand 35! And this was only 7 years after the first siege of Zaragoza, when a powerful French attack was beaten off after 40 days of siege, in spite of the fact that the defences of the place, judged by the standard of the time, were negligible.

Against this criticism of British engineers in 1815 must be set a great piece of work executed by them in 1810, the far-famed lines of Torres Vedras, thrown up to cover Lisbon. The distance they covered was about 24 miles as the crow flies. When it became apparent to the Duke of Wellington that some place must be prepared which should afford a protected point of concentration for the whole of the defensive forces of Portugal, he selected the neighbourhood of Torres Vedras and judged that the scheme would be rendered practicable by means of a chain of fortified posts extending across the Peninsula from the Tagus to the sea.

It is not necessary to enter upon the details of the works which will be found fully recorded in the Memoranda written by Colonel J. T. Jones, R.E., one of the executive engineer officers. They consisted in the main of a chain of redoubts and entrenched batteries, adapted in every case to suit the ground, while obstacles were freely but judiciously used. Communications in what would be the enemy's zone for attack were broken up, while in the lines themselves everything was done to improve them. Artillery, stores of all kinds, supplies and water were amply provided and very complete arrangements were made for the transmission of intelligence (messages passed by signal telegraph from one extremity to the other in seven minutes).

In short all the ingredients for a successful defence were present, starting from the commander and troops, and history tells how the enemy did not risk an attack.

Some of Colonel Jones' words on the subject of these lines are well

worthy of repetition, as they enunciate the fundamental principles of modern fortification. "Throughout the whole front there was not a continuity of artificial line necessitating a single brigade to be kept out of column, and the works may be regarded as so much additional strength given to the army, without subtracting a man from its effective force. Indeed the artificial defences of the lines altogether present a most favourable example of the engineer's art in furtherance of, but invariably subservient to tactics, creating pivots and supports, but never a tie or restraint on field movements."

Apart from the efforts, mentioned above, to amend the bastioned trace itself, a long step in advance was made when a method of fortifying was proposed in which the weapons of the defence could have a freer scope than in a bastioned front, and in which the means adopted for flanking the obstacle were more markedly separated from and did not interfere with the main line of combat. This method was the introduction of "polygonal" fortification by the French General Montalembert about 1780. The outstanding features of this were that the enceinte was composed of straight lines of parapet and ditch which were flanked by projections, a form of the old caponier, from the centre of each length. By this arrangement two advantages were obtained. In the first place the frontal fire from the main line was increased, and was kept entirely separate from the flanking fire. And in the second place the flanking fire was rendered more efficient than it was in the bastioned trace, where effect was lost by the crossing of the fire from the flanks of two adjacent bastions.

Although the originator of polygonal fortification was a Frenchman, like all prophets he had little honour in his own country and the French engineers remained faithful to the bastioned trace until after the Franco-German War. Montalembert's ideas however gained followers in Germany and *Plate* IV. shows the example of Posen which was fortified by General Brèze in 1828 according to this method. In 1856 the same was applied to the enceinte of Antwerp by Colonel Brialmont. In this latter case such a wealth of detail in flanking arrangements was added that the valuable simplicity of the system was greatly obscured.

SECTION II.

What may be termed the third or modern period of fortification can be taken as commencing some time in the earlier half of the 19th century when a large amount of fortification was carried out. From this time onwards the history of the art becomes more difficult to follow than in the previous periods, because we are still under the influence of the details of the time and have not been able yet to appreciate fully the leading principles only.

About the time mentioned various influences, which had been at work in their usual slow manner, produced visible results in the fortresses then built. The chief of these influences was the gradual improvement of artillery both in accuracy and range, necessitating the pushing out of the defence works further from the kernel, but in addition to this must be mentioned the growth of the offensive idea, that the garrison of a fortress were not meant to remain passive behind a wall but were to have freedom and room to manœuvre and strike a blow for themselves.

The visible result of these tendencies was seen in the erection of rings of forts round many places in order to supplement the old continuous lines, *e.g.* Paris, Coblentz, Verona, Cracovia and, in England, Gosport. The distances of these forts from the enceinte varied from 500 to 2,000 yards and even more. It must be noted that these forts were not looked on in the same way in which we regard similar works now, namely as the main line of defence, the art had not moved so fast. They were still advanced works and the main line was still considered to be the enceinte (*Plate* V., *Fig.* 1).

It may be worth while here to consider the arguments in favour of a ring of detached forts as opposed to an advanced continuous line. One is that the latter is much more expensive, another and most important one that it locks up a larger number of troops in purely defensive works. Also if a continuous line is once pierced the whole line is turned, while detached works can protect themselves from all-round attack and can assist in the defence of the intervals between them. Finally it may be added that the offensive idea is furthered more by the creation of a series of strong points, which can protect and support the advance and retirement of local counter-attacks, than by a continuous line of works which hampers offensive movements and teaches men to rely too much on a material obstacle instead of on fighting. It is interesting to recall that at St. Helena, Napoleon, in referring to a project for the defence of

Cherbourg, stated his preference for a ring of detached works over a continuous line.

The advance thus made may be said to have rung the death knell of geometrical fortification. The art might and would have its ebbs and flows but never again would arguments be based on the number of defensive lines of a fortress or on the value of a particular angle between two faces, or on the exact proportion which the perpendicular of a front of fortification should bear to its length.

These new forts were all armed with artillery and in many cases were practically miniature fortresses, *e.g.* the Paris works. Some of the forts were bastioned as at Paris and Metz, others were of a simpler trace, really polygonal, with straight faces, the ditches being flanked by caponiers, *e.g.* Coblentz, Cologne, Verona and Gosport, (*Plate* V., *Fig.* 2). The latter type was undoubtedly superior, as the bastioned trace was peculiarly ill-adapted for a small work since all the parts became very cramped.

In the middle of the century came the Crimean War with the famous Siege of Sebastopol which taught the value of an intelligent fortification of vital points combined with a very active defence. Shortly afterwards in England the well-known Royal Commission on the National Defences was appointed, in 1859.

This Commission, often decried as extravagant and old-fashioned, may have spent money freely but they were more than abreast of the times.* It must be remembered that this country had just taken part in a big European war and this fact cannot but have influenced the Commission in deciding the scale and design of their works. As it was, they placed the defences of our naval ports in a position of strength such as they had not been in for many a day and the works then erected, although in some ways behind the times, are still of immense value. Comparing these forts with those of Port Arthur they possess at least as many of the essential qualities of detached works as those which have recently been put to such a severe test.

The Commission displayed great foresight in boldly extending the lines of defence in order to make allowance for the advances in war material in the future. They anticipated what the Franco-German War settled, namely, that the main line of defence must be the line of forts. As regards details their works were an immense advance on anything designed up to their time and were superior to many constructed after them in simplicity and in all that a fort ought to have, *i.e.* clear fields of fire for rifles and guns (they were naturally mainly artillery works), bombproof accommodation for the garrison, good

* Brialmont says in "Progrès de la défense des états et de la fortification permanente depuis Vauban," "Les ingénieurs anglais, après la guerre de Crimée, avaient pris une belle avance sur les ingénieurs des autres pays par la construction des forts et des batteries de Portsmouth et de Plymouth."

flanking fire over the intervals, ample and secure internal communications, a well-flanked efficient obstacle and all the minor though necessary accessories of a work of defence, *e.g.* drainage, water supply, etc. It is true that the measures for the internal defence of the forts and the arrangements for the mutual flanking of the several parts were carried to an extreme but these were characteristic of the time. The trace adopted was a polygonal one, that is, the faces of the forts were to deliver outward fire only and this was not sacrificed in order to flank the obstacle from the parapet. The latter operation was carried out from portions of the works intended for that purpose only.

Eleven years after the Commission began their labours the Franco-German War broke out and this may be said to have finally inaugurated the present period of fortification. During that contest there was a large amount of fortress warfare but most of it was very one-sided. Except two places, Paris and Metz, the fortresses of France were small and old, many of them having existed for 200 years and more. In these cramped places the defenders were exposed to converging fire from all quarters, their lines of defence could easily be enfiladed and taken in reverse, the houses of the towns were so close to the works that they at once suffered from the hostile fire, while offensive movements on the part of the defenders were impossible owing to the want of space for deployment. Is it any wonder then that place after place succumbed to short bombardments? Strassburg, the largest of the unaltered fortresses, was the only one which made any defence worth mentioning against serious attack. At the same time it must be noticed that the garrisons of most of these places were of very poor quality and even the French consider that many of them might have held out longer than they did.

Of the two exceptions, Metz was being fortified on the latest lines when the war commenced. It was blockaded but not besieged as the Germans knew that the large army shut up inside would soon be starved out. Paris had been fortified about 30 years only before the war and was able, partly on that account, to make a good defence, but for various reasons the siege was never really pressed and the fortress fell from the same cause as Metz. A noteworthy point about the siege of Paris was the efficiency of field defences between the forts. The artillery fire of the forts was soon crushed while improvised batteries in the intervals managed to hold their own.

One of the old fortresses however, Belfort, afforded the best instance during the war of a defence conducted in an offensive spirit, due in the first place to the capability of the commandant. In addition to possessing this first requisite for a successful defence Belfort had other advantages over most of the French fortresses in that it had a garrison adequate in numbers and, on the whole, of good quality, and that several months were available, after the outbreak

of war, for defensive preparations. The commandant, Colonel Denfert-Rochereau, saw the necessity of pushing out the line of resistance far beyond the old enceinte (erected by Vauban) in order to prevent the place being smothered by a close converging bombardment and to give him some room for manœuvring his troops. In pursuance of this scheme he took the following measures. Three strong redoubts were made, two on the ridge of Les Perches, and one, Bellevue, on the west of the town near Fort Les Barres which had been already constructed (*Plate* VI.). He fortified the outlying villages and farms, such as Perouse and Danjoutin, and held on to them as long as possible. Great use was made of indirect fire batteries ("tirant sans voir et sans être vues") which could not be silenced by the besiegers, while constant small sorties were made and companies were specially organized to carry out annoying offensive movements against the enemy and his works. In one or two instances counter-approaches were thrown out to thwart a forward movement of the attackers. In fact the commandant did everything possible to make his defence an active one, with the result that the besiegers were kept at bay till the end of the war and that Belfort is French territory to this day.

The siege of Belfort is an excellent example of the fact, so often ignored, that the main factor in the defence of a place is its garrison. The nature of the defence works is a secondary matter provided that they are not out of touch with the tactical spirit of the time, as were so many of the French places. As a proof that the Belfort works did not fall under this category, it is sufficient to recall the fact that the two small redoubts on Les Perches had to be attacked in "regular form" by trench work. In the words of Capt. Thiers, one of the defenders and the historian of the siege, Colonel Denfert-Rochereau considered that the fortress should be regarded "rather as a secure *point d'appui* for the mobile garrison and a large battery of position, allowing them under its protection to make an effective resistance, than as a line of defence to which they must be restricted from the outset."

As usual after a campaign a long time was taken in assimilating the lessons taught by the Franco-German War in the realm of fortification. The most evident of these was certainly grasped at once, that the line of defence must be pushed much further out but this had already been urged and carried out in many places so that the war served only to accentuate its necessity. From this time onwards the line of defence was in every case a ring of detached works. They still served as artillery positions and the new forts constructed were very similar (*Plate* VII.) to those designed for the 1859 Commission in England. A large amount of fortification work was done at this period in France and Germany, a peculiarity of the French forts being that they contained a double parapet, low in front

and high behind. In some forts the guns were placed on the high parapet with the infantry on the low, while in others the reverse was the case.

But, in addition to the creation of large fortresses, a number of isolated works were made on the Continent both at this time and later. They were intended to bar or delay the advance of an enemy along certain roads or railways and to compel him to use others. Such works are usually termed "barrier" forts and have found their special application in mountainous countries, many examples existing in the Vosges and in the Swiss and Italian Alps. Plans of a mountain barrier fort are given on *Plate* V., *Military Engineering*, Part II., 1910.

Forts like these had to be self-contained, counting on no support from the outside. They were really strongly entrenched batteries, containing guns to command the particular line of approach they were guarding, together with infantry garrisons to secure the safety of the guns.

In fairly open country the value of these forts seems to be distinctly problematical, even though at the present time the guns may have armoured protection. They are not pivots for a force acting outside them, they stand alone and their offensive action is practically confined to the fire of their own guns. They form a good target for the enemy's fire and under that fire it is doubtful if any offensive action would be possible. So far as passive defence is concerned they may undoubtedly be able to hold out for some time and so fulfil their object. But if ever an assault on a fort should succeed, it should be against an isolated fort in country such as this.

In confined defiles however, barrier forts may be well worth the money laid out on them, as positions for hostile artillery will be very hard to find and attacking infantry will be limited to certain lines of approach.

The eminent French General Langlois is a strenuous opponent of barrier forts for the defence of his country, as was shown in his articles in *Le Temps* in 1907.

As already stated it is somewhat difficult in this modern period of fortification to trace clearly the different steps of progress, therefore it might be well at this point to recapitulate briefly the organization of the fortress of the time immediately succeeding the Franco-German War.

The usual constitution of a fortress at this time was :—

(*a*). A chain of forts at distances out from the town which varied greatly but averaged about 7,000 yards, while their average interval was about 3,500 yards. The forts were primarily artillery works and mounted from 20 to 40 guns each but in addition they had infantry garrisons for their own defence. The artillery was mainly intended for frontal fire but a fair proportion of the pieces gave flanking fire over the intervals between the forts.

(*b*). Field defences in the intervals consisting of fortified localities such as villages, farms, woods, etc., as well as redoubts and trenches in more open ground. All these works were positions for the mobile force of the garrison. A certain number of guns were also mounted in batteries of a field type between the forts.

Taking the above organization into consideration, it is at once apparent that this type of fortress had far more possibilities for a defence of an offensive character than the old continuous line. Greater facilities were provided for fire, fewer troops were locked up in purely defensive positions and the major portion of the garrison had a fair space for manœuvring which could be done under the protection and support of secure pivots.

(*c*). But in most of the fortresses of this time there was another part of the defences which cannot be passed over without notice, and that is the interior continuous line. In many cases this was a survival from older times, but even at the present day (1911) it may be said that most of the Continental engineers lay stress on the necessity for the provision of such a line in peace time. In one or two places this has been provided since the Franco-German War.

It is generally stated that the object of this line is threefold :—

(i.). To afford support to the fort belt.

(ii.). To prevent a fortress being "rushed."

(iii.). To allow the defence to be carried on after the fort belt has fallen.

It may be said at once that according to what may be called British ideas (although it can hardly be said that a British school of fortification exists) an interior continuous line constructed in peace time is considered not only unnecessary but even harmful. The lack of necessity for it will be seen by taking the three objects of an enceinte *seriatim* :—

(i.). It can be of no support to the fort belt on account of the distance between the two.

(ii.). In these days it is hardly possible to imagine a fortress being "rushed." Even if it were possible to penetrate the intervals of the fort belt of a properly organized fortress, leaving the forts untaken, such an operation would be so hazardous that its almost inevitable result would be disaster to the attacking party. If the state of the garrison and defences of a fortress gave this operation any chance of success, it seems more than doubtful if any enceinte would stop the attack, as the garrison must be either practically non-existent or negligible.

(iii.). It is possible that an interior line might enable a fortress to hold out for a day or two longer, but the experiences of the Franco-German War do not lead one to expect more than this. Besides it must be remembered that a retreat on to the enceinte ! from the line of facts could only occur in the case of a badly beaten army, while the improvements in weapons since 1870 would, in these circumstances, certainly tell in favour of the victorious assailant.

The foregoing remarks refer only to permanent second lines erected in peace time. They do not apply to retrenchments which should always be prepared during a siege behind the front of attack, when it is seen that they may be needed.

An interior continuous line must, from its expense, be restricted in its perimeter and so be close to the town. With the passage of years it will either prove a great restraint on the growth of the town, as at Strassburg and Antwerp, or its field of fire will be neglected and buildings will be allowed to grow up close to the line, destroying any value that it might have had.

The harmfulness of an enceinte arises from the fact that its provision in peace time will divert money from the main position, while it is likely that if the second line is insisted on and its importance made much of, it will have a bad moral influence on the troops holding the main line as they will be inclined to feel that they always have it to fall back on.

At Port Arthur a continuous interior line was included in the preparations for defence. A great deal of money and labour was spent on it which could far better have been expended on the fort belt, which was never completed. In the end the fortress fell along with the forts, and the value of the enceinte had been absolutely *nil*.

SECTION III.

The most striking lesson, as regards fortification, to be deduced from the events of the war of 1870, was not grasped for several years after that struggle. This lesson was that in a fort, artillery, mounted in the ordinary way on an open parapet, is at a very great disadvantage compared with the attacker's artillery, and that something must be done to counteract this. On consideration it now seems strange that this conclusion had not been arrived at before. A fort was a conspicuous defined envelope in which were a number of guns necessarily crowded. The opposing artillery was scattered over a wide arc of ground, only a small number of guns being in each battery and these batteries were very inconspicuous. Thus the fort became a focus of convergent fire and yet it was expected that the defence artillery was to be served as usual and bring an effective fire on the attack under these conditions. On the face of it the thing was impossible and unprejudiced consideration of the effect of the German fire on the forts of Paris would have brought out the point.

The disadvantage to which the defence artillery in the forts was exposed was further increased as time went on by the growing improvements in the manufacture of artillery material. These allowed that arm to make use of much more accurate pieces for the delivery of indirect and high angle fire, and also furnished it with a bursting charge for its shell of a very much greater power than of the gunpowder of the past. These last two improvements may be said to have brought matters to a head for the time and the solution of the problem of how to meet these new conditions has produced the various ideas of the present day.

Recognition of the fact that two new factors had arisen, which could not be ignored by fortress engineers, may be said to date from about the year 1885. About this time several experiments took place on the Continent which demonstrated the accuracy of the new weapons and the power of their shell. Once more the whole question of fortress organization came into the melting pot, as not only were the artillery tactics unsettled, but the functions of the forts had to be decided anew, in fact the necessity for their very existence was debated.

The experiments of 1885, which proved the culminating point to many years of trials, had a very great effect on the Continent. The French regard this date as a veritable epoch, and reckon present-day fortification from that time. In many places the usual result followed

the production of improved war material; it was considered that fortification was revolutionized and that none of the existing works would be of any use in face of these new developments. After a time however saner counsels prevailed, and it was recognized that an upheaval of ideas was not indicated, but that modifications of the existing fortifications would meet the case. This more rational conclusion may have been hastened by the inevitable check upon reformers in any costly art, the lack of money. Where fortresses of a fairly modern type are in existence it would require the most convincing arguments to make any Chancellor of the Exchequer produce sufficient funds to rebuild them. Minor additions or alterations are all that can be looked for. It is only when a new fortress is going to be established, or when one which is hopelessly behind the times has to be renewed, that the latest ideas can as a rule have full sway.

The new factors which had arisen divided the engineers of the Continent into two main schools, which may be termed those of concentrated fortification and dispersed fortification. In the first the artillery and infantry were united in the forts, in the second they were separated, the forts being for infantry only.

The adherents of the first school contended that the forts were the proper places for the artillery, they had always been built as such and occupied good artillery positions. Guns inside forts were well protected from infantry attack and were always ready for use. It was argued that all that had to be done to meet the new requirements was to protect the guns in an adequate manner, and, since modern developments had placed such power in the hands of the gunner, the only material which could give the needful protection was metal, which had shown such wonderful endurance at the trials in Roumania and elsewhere.

The disciples of the school of dispersed fortification maintained that it was unsound to combine artillery and infantry in the same work. The former was mainly the distant organ of defence while the latter was the near organ. Doubtless they were closely allied and were mutually dependent but it was argued that they would be more likely to carry out their proper functions to the best advantage if they were each allowed to choose the position most suited to them. It was contended also that artillery could be protected adequately by dispersing it and by choosing suitable concealed positions in the same way that the besiegers did with the siege train, and that this very dispersion would be advantageous in the use of the pieces. According to this school as the artillery were taken out of the forts the latter became infantry works, forming strong points in the belt of defence, able at the same time to sweep the intervals with their fire.

Both schools advocated an active defence demanding a mobile

garrison with positions prepared for it to fight in, but this was more emphasized in the case of the dispersed school.

It will be worth while here to examine briefly the fundamental difference between the two schools. It is evident that the concentrated and armoured school laid most stress on the necessity for guarding against the blows *of* the enemy, while the dispersed school thought more of the organization whereby blows may be aimed *at* the enemy. The latter principle seems undoubtedly to be the sounder of the two. It can hardly be gainsaid that the whole history of fortification has brought out the fact that the spirit of the offensive is getting more and more manifest in every step of the art. In spite of this, one or two of the Continental nations adopted the methods of the concentrated school. But one very noteworthy point is that it was the smaller nations, such as Belgium, and Roumania, which did this in a whole-hearted manner, while the Great Powers were inclined to favour the more offensive idea.

In the case of the concentrated school the use of armour for the protection of the artillery was essential but armour was advocated by many adherents of the dispersed school also. On ships of war the use of armour is at present indispensable but the conditions on sea and on land are very different, and there would appear to be several serious drawbacks to the employment of heavy armour for the protection of fortress guns. These drawbacks are :—

(i.). Armoured guns, except those of the very small calibres, are immovable, and they must be mounted in peace time so that their positions will be known to the enemy who will be able at his leisure to select suitable attacking positions and even take the ranges from these positions.

(ii.). Service of guns underneath heavy armour can never be so easy as in the open.

(iii.). The provision of armour is a very expensive matter. For the price of one 12-c.m. howitzer in a cupola at the present day five or six 15-c.m. howitzers could be provided in the open.

These reasons, coupled with the results of the experience of Paris, Belfort and Port Arthur, which showed that guns could be effectively worked from and adequately protected by concealed positions, lead one to think that in the employment of heavy armour for the protection of the main artillery of a fortress too much of the offensive has been sacrificed to the defensive without due need.

One does not doubt that under certain conditions an armoured fortress may render a good account of itself and this study will have failed in its object if it has not made it clear that works are secondary and men are primary.

But the crux of the matter lies in this question. During the course of the siege, which will give, for the outlay involved, the best return in dividends of damage to the enemy,—the one fixed gun behind armour or the five or six in the open? The question still requires practical settlement by the test of war, as hitherto armoured guns for land defence have never been subjected to this trial.

The various ways in which Continental engineers sought to meet the new conditions are set forth briefly in the following paragraphs. Only actual fortresses are referred to, except in the case of the works proposed by one anonymous writer which seem to have in them the germs of the future fortress. From the nature of the subject the information about the works of other countries cannot but be fragmentary and probably is in many cases more or less wide of the truth. The fortresses in which armour plays a large part will first be considered.

In 1886 Roumania wished to fortify a position on the Sereth River from near Foksani to Galatz. For this purpose the Government obtained the services of a Prussian engineer, Major Schumann, who had already made a name for himself as a whole-hearted adherent of the use of armour. The works were divided into three groups, those of Foksani, Nemolana and Galatz. It will suffice here to notice the largest group, that of Foksani, commonly known as the lines of Sereth. Schumann was evidently one of those who were under the impression that the latest improvements in artillery had revolutionized fortification and, having a free hand, he produced the lines of Sereth which have never been imitated and stand alone as a monument of hasty judgment and false reading of history. The details of these works are explained by *Plate* VIII.

They consisted of three rows of very short shallow works placed in echelon at roughly equal intervals on the perimeter, they had no flanks and no arrangements for infantry but all had armoured guns, the heaviest being in the back row of works and the lightest in front. The infantry of the garrison were all to be massed and no works were prepared for them, they were to fight as a field force.

Here there certainly is a revolutionized fortification, it is dispersed indeed, but in a unique way. The infantry who are the principal arm, must stand long bombardment without shelter or be absent from their place when they will be wanted most of all. When they do advance they must do so without strong points on which to hinge their movement and they will probably suffer severely from the fire of their own guns scattered over the face of the ground.

As regards the artillery Sir George Clarke describes the utter hopelessness of trying to control the fire of such a line of defences under the normal conditions of a siege (*Fortification*, 2nd edition, p. 97), while a French author says in reference to this place "mechanism cannot replace men." Apart from the design of the

works it is generally considered that the position can be turned fairly easily.

Although the full application of the ideas of Schumann is not likely to be seen again, there is no doubt that he has had a considerable influence upon the fortification of the Continent by the introduction of his armoured mountings for artillery. The original idea of these emanates from an Englishman, Capt. Coles, who constructed a turret for the Belgian Government in 1862. This was a cylindrical structure but subsequent improvements produced the inverted-saucer shape which is now used universally. In addition to that of Schumann the names best known in the design of armoured mountings for artillery are Mougin and Galopin. The heaviest piece mounted in these cupolas is the 15-c.m. gun for direct fire and the 21-c.m. mortar for high angle fire. Two of the cupolas are shown on *Plate* IX.

Passing from the abnormal instance of Sereth we come to the really concentrated school which must be taken more seriously as it has examples in two at least of the Continental nations and does not cast aside all the teaching of the past. Its chief exponent, in fact it might be said its author, was the Belgian General Brialmont who constructed the enceinte of Antwerp in 1856. He was directly responsible for works in Belgium and Roumania, and largely influenced the design of the Copenhagen works, while German and Austrian fortifications also owe something to him. Judging from his writings he was greatly impressed by the experiments of the 1885 epoch (at Malmaison, Cotreceni and Bourges) and, when in 1887 he was ordered to fortify Liège and Namur, he had the opportunity of putting into practice his ideas of how the new factors in the artillery world were to be neutralized.

He considered that the fort was the main if not the sole feature of the fortress and that it should play its part from the beginning to the end of the struggle. In other words he united the distant and the near organs of the defence in the closest possible bond. His forts, while they showed variation in trace and details always contained the same main ideas. They were primarily intended as artillery works and were sited as such, consequently they were very prominent. The main artillery was in cupolas concentrated in a vast concrete mass in the centre of the fort. This was surrounded by a parapet arranged for rifle fire and in the parapet were also light guns under armour for the near defence of the fort and for sweeping the intervals between the forts. The whole work was enclosed by a deep well-flanked ditch. One of these forts is shown on *Plate* X.

Liège and Namur were commenced in 1888 and finished three years later (*Plate* XI.). In 1889 Brialmont designed the forts round Bucharest, the capital of Roumania, which are of a type very similar to those of the works on the Meuse.

In Brialmont's forts, apart from the general question of the use of

armour, the grouping of the cupolas makes them a better target for the opposing artillery than if they were in a line parallel to the front. Also, the practice of using light guns in all-round fire tourelles for the double purpose of close defence and sweeping the intervals is open to the objection that these guns may be so taken up with the defence of their own fort that they will not be able to devote any attention to the intervals.

In Belgium at the present time the fortress of Antwerp is once more being remodelled, this time according to the scheme of General Docteur, whose staff officer is Major Deguise, the author of several works on fortification. The old enceinte is being demolished and a new one formed on the line of and including the forts erected in 1860. The main line of defence is being thrown farther out and it would seem that the ideas of Brialmont have been departed from to a certain extent. The new forts are to have a "safety" armament only, protected by armour it is true, but the majority of the artillery will be in armoured batteries in the intervals. Thus, although great use is still to be made of armour, the general principle of the separation of the distant and near organs of defence has been recognized and acted on.

Another modern fortress of the armoured type is Copenhagen which is unique in several respects. It was commenced by Colonel Sommerfeldt in the year 1885 and was finished about 1894. The work was the result of the report of two Commissions on the national defences in 1872 and 1883.

In the scheme of the fortress inundations play a very large part as will be seen from *Plate* XII., and the whole of the works seem to lend themselves more to a passive than an active defence. The left half of the defensive girdle consists of a continuous line of rampart and wet ditch flanked by artillery caponiers at intervals. This line was intended to be a protection for the artillery of the defence, and magazines and bombproofs have been formed in the parapet. The site is very flat and marshy and the problem of how to deal with it is a hard one. Attack on this front is improbable but the defence would have to be a passive one. This reversion to a continuous line in the case of a modern fortress is peculiar and its wisdom would seem distinctly doubtful, the number of men required to man the line being very considerable.

The right half of the girdle consists, so far as the permanent works are concerned, of a double row of isolated batteries. The guns of the front row are armoured and are intended to force the artillery of the attack to bring up its pieces to close range in order to make an impression on the works. The second row, which is on higher ground than the front, is one of open earthen batteries which are to serve as pivots for the artillery position of the defence, while between these batteries will be the positions for the infantry.

Here then we have the artillery and infantry organs of the defence completely separated but in the reverse manner to that usually adopted by the dispersed school of fortification, as the guns are in permanent works while the infantry have to depend altogether on fieldworks.

The armoured batteries of the front line, which are the interesting part of the fortress consist of huge masses of concrete containing the cupolas. The guns just clear the glacis so that the works are not conspicuous. There is no infantry parapet but each battery is surrounded by a deep ditch flanked by caponiers.

The modern fortresses mentioned hitherto have belonged to the small European Powers whose attitude must be that of defence only. But fortification plays a great part in the plans of the Great Powers also.

Germany adopted the tenets of the dispersed school at an early date and removed the majority of the guns from forts leaving only the safety armament which was to deal with the investing columns of the enemy but was not to take part in the artillery contest. The main artillery was to be placed in batteries in the intervals between the forts and a great deal of attention was paid to the organization of the intervals. Permanent magazines were erected for the batteries to be made on the outbreak of war and bombproof shelters were put up for the infantry. The German engineers adopted armour for the protection of a few guns at an early date. In 1865 Schumann constructed armoured casemates for guns at Fort Bingen in front of Coblentz, in 1873 Gruson cupolas were placed in Forts Woippy and St. Quentin at Metz, while in 1874 armoured caponiers were erected on the revised enceinte of Strassburg.

But there are indications that more recently Germany has made greater use of armoured protection for artillery. Although Schumann did not get the free hand in his own country that he did in Roumania, still his influence as regards the use of armour was considerable, as was that of Brialmont. This is exemplified by the well-known works at Molsheim which were erected about 1894. It must be remembered that these forts are not part of a fortress but form a group of barrier works where the use of armoured guns would seem to be justified. *Plate* XIII. shows one of the Molsheim forts. Here there is the same central concrete mass for the cupolas as in the Belgian forts but in this case they contain howitzers only, while the same infantry envelope surrounds the mass, protected in its turn by a well-flanked ditch and light guns in tourelles on the parapet. The plan of the fort strongly resembles one of Brialmont's works while the cupolas are very similar to those of Schumann.

No new fortress has been built in Germany since 1887, any fortification work has been in connection with the strengthening of existing forts. But in 1899 the Germans commenced at Metz what appears to be a real development of the art in the direction pointed out by the

reading of history, that is, in the increase of the power of the offensive. So far as can be found out these new works would seem to be an adaptation of the ideas of an anonymous writer who put them forward in 1887 in a pamphlet entitled "Les Forts et la Mélinite" under the *nom de plume* of "Un Pionnier." He advocated splitting up the different elements of a fort (as it had been hitherto understood), artillery, infantry, stores, magazines, shelters, etc., and scattering them over a large area, thus permitting each part to be sited within limits, according to the work which it had to do. He surrounded the whole area with a belt of obstacle. The ideas thus brought forward will be best understood by reference to *Plate* XIV., which is copied from the pamphlet, but it must be remembered that this plate is a diagram only.

It is at once seen that the so-called forts proposed by this writer belong to the dispersed school of fortification. They undoubtedly give the artillery and infantry a better chance of being of use than the old pattern of fort did, and at the same time the target presented to the attacker is a very much more difficult one on account of its dispersion, and the inconspicuousness of the various works composing it. Dispersion of the old fort elements in this way is generally termed "grouping."

Returning to the new works at Metz it is noteworthy that they have been pushed out to as much as 9 miles from the kernel, but it is not certain whether they are to be regarded as a new main line of defence or as a series of very strong advanced positions. The approximate position of those at Metz are shown on *Plate* XV. It would seem that similar works are being erected at Thionville and Isteiner Klotz to the north of Basle.

The details of these works are naturally known to a very imperfect extent only and *Plate* XVI. must be regarded merely as an approximate diagram but it shows the probable organization. The works are of a novel type and have a considerable resemblance to those proposed by "Un Pionnier" with the exception that the artillery has been given armoured protection. The size is phenomenally large and the infantry and artillery elements are separated to a certain extent while they are all enclosed within a continuous defensible envelope. The Germans style the works "Feste" and not "Forts" and they are really miniature fortresses in themselves. It remains for the future to show what effect they will have in the defence of the place itself.

The two generally accepted alternative reasons for their construction have already been mentioned. Following the usual German idea that one main line only should be prepared in peace time it would seem that these works are to be the principal line of defence, and that under the cover of these satellite fortresses the mobile garrison of the fortress is going to undertake a vigorous offensive.

But if this is so one cannot help the question arising as to whether the intervals between the "Feste" are not too great. On the other hand if the Germans have in this case dropped the principle of one main line and intend to regard these places as advanced posts then it would seem that the garrison of the whole fortress would have to be largely increased to the detriment of the field army. Here again it must be remembered that a very large total number of troops can be reckoned on. Our knowledge of the whole scheme is however so nebulous that criticism is impossible and surmise unprofitable. *Plate* XVI. is taken from *Fortification Cuirassée*, by Colonel Piarron de Mondesir, who has kindly given permission for its reproduction.

The Austrian scheme of a fortress at the present day would seem to follow the lines of the dispersed school but to involve considerable use of armour. The forts are massive works mainly designed for infantry but with light guns in armoured cupolas. Flanking fire over the intervals is obtained by guns in "traditor" casemates protected by armour and concrete. These are casemates firing to the flank and rear (hence "traditor"). The main artillery, even the safety armament, is in the intervals. Most of the batteries would be erected on the outbreak of war but a few are permanent and the pieces in them have armoured protection. The usual field defences for the mobile garrison would be made in the intervals.

This organization is similar to that of the older German type except for the position of the safety armament. The use of armour as the best obtainable cover for the flanking fire guns seems more than justifiable if natural cover is not to be had. Weapons intended for this purpose will not be required until the later stages of the siege but may be wanted at very short notice. Therefore they must be protected from damage during the early stages and should be always kept in their fighting positions. Guns are very much better suited than rifles for the purpose.

The latest Austrian fortresses are Cracow and Przemysl in Galicia on the northern frontier and Trent in the mountains of the Southern Tyrol.

The ideas of the French engineers as to fortress organization are not greatly dissimilar from those of the Germans. As already stated a large amount of fortification work was done in France after the war of 1870. This was carried out under the advice of a Commission appointed in 1874, the head of which was General de Rivières, his staff officer being Commandant Mougin of armour fame.

The nature of the work done under this Commission has been mentioned already but it might be added that towards 1880 some existing gun casemates were transformed by giving them armoured protection, and some of Mougin's cupolas were also introduced.

At the "epoch" of 1885 the French reconsidered their fortifications *de novo* and made extensive trials of the improved artillery material

and of armour at Laon in 1886, Bourges in 1887, and Chalons in 1888. They then made certain changes in the organization of their fortresses but did not go in for armour to any great extent. A few guns were still retained in the forts as safety armament but the majority were removed to be placed in batteries in the intervals, to be made on the outbreak of war, while the forts, although they were still artillery positions for the safety armament, were regarded mainly as infantry works.

The use of the forts for any frontal fire artillery handicaps them when they come to be used for infantry, since they are in such prominent positions, but in the case of France as elsewhere this may be accounted for by the fact that no new forts have been built lately so that all that could be done, when amelioration became necessary, was to make the best use of those already existing.

In addition to this reduction in the armament of the forts the bombproof protection was considerably thickened by the addition of concrete to the existing roofs and the caponiers which flanked the ditches were replaced by counterscarp galleries as the former were thought to be too exposed.

In 1899 a new Commission was appointed which drew up certain rules for the organization of fortresses. The *points d'appui* were considered to be of two natures, the forts themselves and strong intermediate works placed between them, one in each interval, to assure the proper flanking of the ground. (The difference between these two classes of work would seem to be one of size only). Guns for the close defence and for flanking were to be placed either in tourelles or in ferro-concrete casemates. The safety armament was retained but reduced in number. According to the usual French practice great importance was attached to advanced positions. A recent example of the use of armoured guns by the French is the erection of small tourelles for the defence of their Legation at Pekin.

For various reasons the Russians have not done much fortification work in modern times, but as far as can be gathered they are in sympathy with the dispersed school in separating the artillery and infantry elements of the defence. They have never hitherto adopted any form of armoured defence but their best known engineer, General Welichko, who was at one time a strenuous opponent of armour, has recently become an advocate of it.

However Russia has given us the latest example of the defence of a fortress in the case of Port Arthur in 1904. General Welichko was sent out to this place in 1899 to revise the fortifications, but his scheme was only partially followed and, when war broke out in the beginning of 1904, a great deal of work still required to be done on the defences of the fortress.

Port Arthur is the only fortress of a modern type which has been subjected to the supreme test of war, so that a brief study of the

siege should prove of considerable value. But the events are still too recent to allow us to obtain the full instructional benefit of this tremendous struggle. Opinions formed to-day may well have to be modified to-morrow in the light of fuller information and more dispassionate criticism.

Full details of the fortress are given in the *British Official History of the Russo-Japanese War*, Part III., so that they need not be repeated here at length. It will be sufficient to point out a few prominent features.

(i.). The forts were not finished when the war began. They were in the front line and were very conspicuous, being sited on spurs projecting from a steep ridge towards the enemy.

They were intended for infantry only except Fort Ehrlung which had four and Fort Sungshu which had two guns. Their internal arrangement was simple. They had all-round infantry parapets which had been hastily provided with head and overhead cover, case-mates proof against all but very heavy shell, flanked deep ditches, but poor internal communications where considerable loss of life occurred.

(ii.). Two of the permanent forts attacked had about 150 yards of dead ground in front of them, starting from about 40 yards from the parapet.

The forts and the provisional works were at very close intervals and their flanking fire, especially from light Q.F. and machine guns, was very effective indeed. (Two most useful flanking guns were situated at an advanced provisional work behind a knoll and caused great trouble to the attackers before they could be silenced).

All the forts had fire trenches in front of them, which proved of great value.

(iii.). A number of the guns of the main artillery were mounted in positions which were very prominent owing to the steep slopes of the foreground. All these guns as well as those in the two forts mentioned were soon put out of action by the Japanese fire. The majority of the weapons for carrying on the artillery duel were in more retired positions and received little damage during the siege. None of the guns were under armour.

(iv.). The trenches were not provided with traverses and head cover until experience had proved that they were necessary.

(v.). A great feature of the defences was the Chinese wall. This was a continuous rampart of mud and stones, about 10′ high and 20′ thick at the base, with an infantry banquette to which the Russians had added loopholes and overhead cover with bombproofs under the banquette.

(vi.). A continuous inner line was provided near the town with a heavy parapet and deep ditch, small forts being made at intervals in the perimeter. This work required an immense amount of labour for its construction and it proved absolutely useless.

Viewing the defence as a whole it seems to bear out once more the old lesson that the garrison is the main factor of a fortress, provided that the fortifications are not out of touch with the tactics of the day. Little niceties of design are of small account.

In this fortress the works were incomplete, two out of the three permanent forts attacked had a belt of dead ground close in front of them, the internal communications of the forts were very bad, a large amount of the artillery was very conspicuous, and finally the defenders showed that they had completely lost the skill in mine warfare of their fathers at Sebastopol. Turning to the attackers, although they were slow in taking to scientific methods for the conduct of the siege and were too eager to try open assaults, they will be famous for all time for their brilliant courage.

Yet, in spite of all these adverse conditions, Port Arthur held out for 154 days after the close investment and the commandant was tried and condemned by court-martial for not holding out longer.

What was it then that enabled the defence to be prolonged to this extent? Here caution must be exercised in giving an opinion as the full facts are not yet digested, but it can be said that some at least of the essentials for a good defence were present in the place.

Firstly, the garrison, supplies, and stores were sufficient in numbers. The troops showed that they were possessed of dogged resolution, fighting their works until they were shapeless masses. Also the commander of the land front, the leading spirit of the defence, General Kondratenko, (killed a fortnight before the capitulation) was a most able officer.

Secondly, the works with all their faults gave good development to the fire of the defenders, especially from the light gun, the machine gun, and the rifle (the most important weapons in fortress defence). They supported each other admirably and did not hinder offensive movements. Great stress has been laid on the usefulness of the Chinese wall. This would seem to have been due, not to the obstacle which it presented, as that was very slight, but to the fact that it could be used anywhere as a fire position to repel an attack.

It is probable that its continuity was actually some restraint to offensive movement.

It is profitless to speculate whether Port Arthur could have held out longer if the forts had possessed armoured guns. That cannot be decided until several armoured fortresses have stood the same test.

On the whole a greater number of lessons can be learned from the attack of Port Arthur than from its defence. Before this war speculation was rife as to what methods a modern siege must follow in the close attack because it was held that siege warfare had been "revolutionized." An English authority had said that the engineer attack was "either unnecessary or impossible," while the same opinion was expressed in France by an eminent artillery officer in the words "le cheminement du Génie est mort." Now, it is known that the old principles hold good, although the distances at which they are applied and the methods by which they are applied have changed. The gunner has still to keep down the defender's fire and ruin his fighting positions, the engineer has still to neutralize, by trench, sap and mine, the advantages of the defender in the shape of the open field of fire and the baffling obstacle. Lastly, when both have done their work, the way will still be open for the infantry, the main fighting arm, to rush the last few yards and close on the defender with the bayonet if he is brave enough to hold out to this stage as the garrison of Port Arthur did.

Thus briefly the progress of the art of fortification has been traced from the introduction of artillery up to the present day. In every step that has been taken the attempt has been made to show the growth of the offensive idea which has been rendered possible by the improvements in weapons.

Plate XVII. shows in diagrammatic form the principal changes and the variations in the size of fortresses in the last four centuries.

SECTION IV.

In the last section a brief description was given of most of the fortress organizations of the present day. In spite of the variations among them, there does seem to be taking place a slow crystallization of design.

The principle of the separation of the distant and near organs of defence may be said to be universally accepted now, as even in Belgium, the home of concentrated fortification, the artillery are to be removed from the forts.

There also seems to be a tendency towards splitting up the *points d'appui*, formerly consisting of forts only, into groups of trenches surrounding the nucleus of a strong closed work. To a small extent this was noticeable at Port Arthur but it must be acknowledged that, except in the case of Germany, this tendency towards "grouping" is evinced more in writings than in facts (*cp.* Leithner, Deguise, Dupommier, Mondesir, Richard). It would seem to be brought about, from the offensive standpoint, by the necessity felt for increasing the fire from *points d'appui*, and from the defensive, by the fact that forts of the old types are too easy targets for hostile fire.

Another point which is coming more and more to the front is that the nucleus of a *point d'appui* should not be on the forward crest, but retired from it in order to be sheltered as much as possible from the enemy's artillery to which it can make no reply.*

When these ideas have been assimilated they will certainly alter our conception of permanent fortification which hitherto has generally been associated with massiveness. But this attribute is by no means essential, and permanent fortification, in its true meaning of fortification prepared in peace time, will still have its place although the "frowning" fortress may have vanished. As General Langlois says, field fortification tends more and more to become a substitute for the old permanent fortification, and this fact must be faced. The reasons he gives are :—

(1). The perfection of firearms, especially the rifle, has given to ordinary field fortification an extraordinary power of resistance, due to the fire, not to the obstacle.

(2). These light fortifications escape to a great extent the effects of the artillery of the attack, not because they are strongly built, but because they are so extended. They present so great a surface that to break down the defence an enormous amount of ammunition would be required.

* This is advocated by many, *e.g.* Sir G. Clarke, Mondesir, Deguise and Richard.

(3). Permanent fortifications (of the type generally understood) on the contrary, consisting of forts of high profile but of small area, can offer only a feeble resistance to large shells charged with high explosives. The strength of resistance lies more in invisibility and in extension of numerous and relatively feeble objectives, than in the accumulation of concrete and armour. For the latter an engine of destruction will always be found which will get the better of them, they have never more than a transitory value and do not justify their expense.

The major portion of this reasoning seems very sound but the last words are too sweeping if by them is meant the condemnation of all strongly built works. The kernels of the *points d'appui*, designed to carry out particular duties in the close defence, will be the better able to do so if they can bid defiance to ordinary field artillery. As these works are of small area, the requisite resisting power, apart from the help afforded by their site, can be attained only by the use of dense materials.

To settle our ideas let it be imagined that an important place, hitherto without defences, is to be prepared for defence in peace time against a possible attack by a large force fully equipped according to modern ideas. What form will the defences take, if it be granted that artillery and infantry are to be so disposed that each arm is to be worked to its fullest extent and not to be cramped in its action by the other ?

We are at once face to face with the question, "is it necessary to erect any works in peace time ?" Wonderful resistances have been made in the past behind field defences thrown up at short notice, so that one may well ask "is it not enough to have the whole scheme of defence by such fieldworks worked out on paper in the fullest detail, and every preparation made for the execution of the works when they are required ?" The cost of the works would be reduced, their position as well as their nature would be unknown to the possible enemy, while the designs could be altered to keep up with any improvements of the day.

This course might be followed in the case of unimportant places in the remote parts of the possible theatre of war where the notice of attack would be a lengthy one, but even there it might be hazardous and would be so in the case of more important places, or those which are nearer to the enemy. One must always assume that one's adversary will be fully equipped, that he will do the right thing and that his movements will be directed with energy, but it is not wise to assume the same for oneself. Now it will be noticed that most of the great defences of history behind field defences, such as Saragoza, Sebastopol, Kars and Plevna, have been directed by great leaders and they have

been carried out at the cost of unusual privations and suffering to the troops. To expect that a Palafox, a Todleben, a Williams or an Osman will always be in command of a fortress is to expect too much from the hand of fortune, while to subject troops to abnormal hardship as a matter of course is to invite disaster. It may be said that this is argument from particular cases; possibly, but the cases are numerous and other arguments can be adduced. At the very time when the military machine is working at its greatest pressure a huge extra amount is suddenly cast upon it. Very large working parties with numerous overseers would be required, time would always be an uncertain factor, and, since we are all human beings, it is extremely probable that work done in a hurry would be inferior to that executed at leisure.

For the reasons thus adduced, another might argue that all defences should be constructed in peace time in order to leave as little as possible to be done in the time of stress. This idea certainly has great attractions, and it will be found that in such fortresses as those on the eastern and western frontiers of France and Germany respectively the amount of work to be done on the outbreak of war has been reduced to a comparatively small proportion of the whole. But the conditions of these places are peculiar, and as a general rule there are drawbacks to such a practice. For one thing it is certain that any possible enemy will possess accurate information about the defences, and for another the inexorable power of pounds, shillings and pence forbids; there would be a large expenditure in upkeep and a loss of income from land standing idle, while alteration of works to meet the tactical trend would be an expensive matter.

As usual the middle course seems advisable; construct in peace time the minimum requisite for temporary safety and have the plans and preparations made for the remainder, meaning by preparations such portions of the intended works as cannot be carried out in the time available after the notice is given. In order to do this for the imaginary place under consideration it will he necessary to decide on the organization of its defences.

It cannot be said that the conclusions now put forward belong to the British school of thought on this subject, because such a thing is extremely nebulous if not non-existent. But it is hoped that it will be found that they have been arrived at from following the lead of history and from definite reasoning.

It will be well to state the data on which the conclusions as to the necessary defences have been arrived at. Put briefly, these are :—

I. The line of defence must be far enough out from the object to be defended to prevent the enemy bombarding it regardless of the defences. At the present time this distance would be roughly from 8,000 to 10,000 yards, according to the ground.

II. The works must be so designed and sited that they lend themselves to an active defence. That is, not only shall they try and prevent passively the enemy's approach and successful assault but they must help the defending troops to destroy the enemy actively. This may be done in three ways :—

(*a*). By fire of all kinds. Therefore every effort must be made to bring into use to their fullest extent rifles, guns and howitzers.

(*b*). By actual counter-attacks. From the circumstances of the case these will have to be local and cannot be carried out by large bodies. But the idea must be kept in mind from the outset and the defence works must be so sited that they can support and protect by their fire the advance and retirement of the troops.

(*c*). By systematic counter-approaches. It is not enough to sit still in the works and merely devote one's energies to strengthening them while the enemy approaches by trench and sap. Preparation must be made to run out counter-saps which shall enfilade the enemy's trenches as these will naturally be so traced that existing works cannot see into them.

III. Forts are not places in which to put artillery.

IV. In peace time and on the approach of war all efforts should be concentrated on one line. Successive lines of defence lead to false ideas and almost inevitably to the starvation of the main line. This is not to say that, when as the siege progresses it is foreseen that the enemy may shortly succeed in his endeavours to break through a portion of the line, a retrenchment should be made behind it, far from it. But at the start every penny and every hour should go to make one line as strong as possible.

V. Economy of men in the works themselves must be studied, so that as many men as possible may be available to carry out the active part of the defence. This end can be furthered by making large use of flanking fire. The employment of this has always been a feature of fortification and probably always will be. As De Ville puts it "the flank is the arm of fortification and must be armoured to preserve it for its use."

Such are the data on which our defence works are to be designed. Assuming that the line of defence has been selected, a matter which will be dictated by the accidents of the ground within the prescribed

limits, it remains to assign their parts and places to the different elements of the defence. These may be divided into :-

1. The *points d'appui* or defensible areas, (formerly consisting of forts only).
2. The artillery.
3. The mobile force or active portion of the defences.

Considering these separately :—

1. Up to the present time the *points d'appui* have consisted of forts in the front line. But is the front line the proper place for a fort if the artillery is removed from it ? Then the functions of forts resolve themselves into their being infantry positions securing important points, capable of sustaining themselves against prolonged attack and of providing fire over a portion at least of the ground between them.

   In the early stages of a siege a fort placed in the front line is an inert target, hammered by the enemy with no chance of reply, so that when in the later stages it should make itself felt it has been so much damaged that its offensive power has been greatly weakened. A visible enclosed space like a fort with an upstanding parapet is an ideal target for artillery of all kinds as it affords a good margin for the inevitable inaccuracy of its fire. A shell which is aimed at the crest of the front parapet may miss its mark but has a good chance of finding a billet elsewhere. Artillery is very accurate as regards "line" but is very much less so as regards "range" even with the best detachments and the latest improvements.

   Taking all this into consideration, is it not better to withdraw the forts from the front line and place them, provided the ground admits, where they can still fullfil their functions but where the enemy's artillery cannot work their will on them at pleasure.

   Still, the foreground must be covered with fire. This can be done from fire trenches in the front line and these will provide for that development of fire which is so necessary. These trenches will certainly be exposed to the whole of the enemy's artillery fire, but a trench is a very bad target. It is inconspicuous and difficult to lay on, and for another thing its depth from front to rear will probably not exceed 10′ at the most, therefore a great deal of ammunition will have to be expended before serious damage is done. In any case the damage can be localized and easily repaired. Let it be borne in mind also that there will not be one trench only in front of a fort but a whole group of them. There is of course the danger that in the close attack trenches such as

these, when captured by the enemy, may become parallels for him. Sometimes the danger from this must be risked, but it will often be possible to site these trenches so that they will have little or no field of fire towards their rear, then they will be of but small value to the enemy. In other places it may be possible to enfilade them from neighbouring works.

A trench however or even a group of trenches has little of what may be called recuperative power in the event of the line being pierced, therefore it will hardly be wise to trust altogether to such forms of defence, especially as troops manning these trenches will be tried highly. Life in a trench under siege conditions will not be pleasant, and there will be both a physical and a moral advantage in having behind these front trenches a work with its own garrison, which is housed under cover, proof for a long time even against direct hits, and protected by an obstacle which requires special appliances and a long time to cross it. There is no question here of the closed work being regarded as a second line, it is part and parcel of the main line which must possess depth and must be organized to hold out to the last extremity.

The defensible areas or *points d'appui* are thus beginning to shape themselves. To recapitulate, in the front line, sweeping the foreground, will be groups of fire trenches provided with all their essential accessories, *e.g.* shelters, communications, obstacles, kitchens, latrines, etc. Behind the trenches at a distance of decisive rifle range, say from 300 to 600 yards should be the forts, always with the proviso that the ground allows such a disposition. Every means must be taken to try and conceal the forts from the enemy's terrestrial observing stations, and this will be facilitated by the fact that the command of the forts can be kept very low since the field of fire is so short.

The forts should be closed works because there can be no question of giving them up, they must be held to the end. The garrisons need not be large, 200 men should suffice generally, but they must have bombproof accommodation since the site of a fort will be known, and in any case it will be impossible to keep it unseen from the enemy's observers in the air. It should be surrounded by the most efficient obstacle and experience has found nothing more effective than the well-flanked deep ditch.

The importance of securing flanking fire has already been mentioned as this will economize men. Sometimes the ground will admit of this being carried out from the forts and, if so, this will have many advantages. Although

flanking fire from rifles will be of value there should be some guns provided for the purpose. Fire of this nature will, more often than not, have to be delivered at night when guns can be depended upon far more than rifles to cover the requisite areas of ground. If these guns can be placed in the forts, their safety from capture will be assured so long as the forts hold out, while it will probably be an easier matter to protect them from the enemy's artillery fire than if they were in the open. Other advantages are that command will be simplified and magazine accommodation will be provided more easily. Flanking weapons are only needed in the later stages of a siege (or in an early assault) and require adequate protection to preserve them. Owing to their position it will often not be possible to give this protection by siting, but a protecting medium will have to be relied on. This should be concrete or steel. In the case of these guns there is no question of sacrificing the offensive to the defensive, they *must* be protected if *any* offensive value is to be got out of them. Guns in casemates would seem to be more suitable than those in turrets or cupolas as probably they would be cheaper, certainly would be quicker in traversing and could not be diverted from their proper function as could guns with an all-round fire.

If the ground does not allow the flanking guns to get their field of fire from the forts, positions must be sought for them outside the forts, but within the perimeter of the *points d'appui* where the field of fire can be obtained. Then special measures must be taken for their protection by the provision of adequate cover.

On certain types of ground the rearward position for forts cannot be obtained on account of the narrowness of a ridge or the steepness of the features. Such positions are to be avoided, but their occupation may be essential and in such cases the forward site must frankly be accepted, and it must be left to the skill of the designer to mitigate the disadvantages of the unavoidable prominence.

The ground will have a great influence in deciding the length of the intervals between the *points d'appui*. Mutual support between works is of the greatest importance so that this must receive adequate consideration.

Probably the distance should lie between the limits of 1,500 and 4,000 yards.

It must be acknowledged that such a *point d'appui* as has been described will require a slightly larger garrison than an old fort did.

But it must be remembered that the extent of ground covered by the work as a whole is much larger than the older type, while its offensive action in the way of fire has been largely increased.

2. The second element of the defence is the artillery. In considering this the following are the points to be borne in mind :—

(*a*). The objectives of defence artillery, apart from their attacking rivals, are men, together with siege works of slight profile and low command but of great extent.

(*b*). A siege is a long operation so that the positions of the defence artillery will sooner or later be located by the enemy.

Therefore, although any artillery can naturally be made of service, heavy pieces are not the type most to be desired in a fortress. What is wanted is mobility and volume of fire, the former to permit movement of detected guns, and the latter because the targets presented will suffer more from a large number of light shell than from a small number of heavy.

Apart from field guns light and medium howitzers would seem to be the pieces best suited for defence artillery on account of their searching power, the ease with which they can be concealed, and the facility with which ammunition can be supplied to them. At the same time a few long range direct-fire guns may be of great service in the earlier stages of the siege.

Probably the best general position for the defence artillery will be between the defensible pivots and behind the line joining them. Placed here, inaccurate fire directed at the one will not damage the other. The nature of the batteries in which the artillery will be placed is dealt with in *Military Engineering*, Part II., as well as the auxiliary services in connection with them.

As a rule in the past, the artillery has not played a very prominent part in the defence of fortresses. One contributory cause may have been the natural tendency on the part of the defenders to husband their ammunition. Port Arthur however emphasized the very great value of light guns and machine guns in repelling an assault. Every possible preparation should therefore be made for their use in the shape of adequate protection, at or near where they are to be used, and ample ammunition supply.

3. Finally there are the preparations required for the mobile force.

The *points d'appui* form a series of strong posts round the object of defence, but there are intervals between them and these are the manœuvring and fighting ground for the mobile force of the garrison. In the treatment of these intervals it must be recognized that there is a difference between the defence of a field position and that of a fortress, just as this difference has to be reckoned with in the organization of the *points d'appui* themselves. It lies in the isolation of the fortress garrison compared with the situation of troops occupying a field position, an isolation involving a daily loss of potential in every way. To minimize this, gradual weakening the defensive side of fortification must be given somewhat greater prominence than in the case of a field position, and the effective power of a small number of men must be multiplied by providing them with facilities for moving rapidly from one threatened spot to another. It is not meant to decry all that has already been said about the value of an active defence, that must always be aimed at, but the offensive movements will be on a small scale and will not require a wide front.

Therefore, in the intervals between the *points d'appui* covering the artillery positions, it would seem that the preparations for the mobile force should consist of :—

(*a*). A series of fire trenches so sited as to sweep the most likely lines of approach.

(*b*). Most carefully arranged covered communications circumferential and radial. This is of the utmost importance.

(*c*). A liberal use of obstacles to detain the enemy as long as possible and give time for the smaller force to make its fire felt.

All these preparations must be made so as to facilitate the counter-movements. The gaps requisite for these must be flanked by fire from some of the works, and as a rule the most important gaps will be those close to the *points d'appui* which will thus be fulfilling one of their proper functions. In a field position it may not be necessary always to provide artificial cover for the local reserves between the defended points, but in a fortress position this must always be done on account of the length of the action.

These interval works will be exposed to the whole of the enemy's fire but a vast expenditure of ammunition would be

required to damage them seriously. Inconspicuousness for these works will naturally be advantageous but the long course of a siege renders this an almost unattainable quality, therefore full use should be made of head cover and overhead cover. The trenches would at most times be manned by a few men only, and life might be made somewhat more bearable for them by providing bombproof accommodation close behind the trenches.

It is not likely that at the commencement of a siege the interval works will have arrived at their full development. That will come only as the attackers show where they are going to try and push home, but in every fortress under given conditions, a very fair guess, within certain limits, can be made of the probable front of attack and there the interval works will mostly be congregated.

In order to illustrate these ideas *Plate* XVIII. has been inserted. A type diagram is never satisfactory so that an actual position has been chosen within the assigned limits, outside an English town.

The above is a brief account of the organization of the proposed defences of the imaginary place under consideration. The question already put can now be returned to. How much of this organization should be actually carried out in peace time ? It is assumed that an adequate garrison, artillery, and stores have been provided since these are the first essentials. This being granted, the next thing is the preparation of the ground. In a field position, *the great difficulty* is that of finding a clear field of fire and the necessity for this is the first requisite of all fortification. Here then is the principal thing that can and should be done in preparing a position for defence in peace time. Choose the best site for the front fire trenches and the supporting forts, and make an absolutely clear field of fire for them. All buildings and natural growths should be removed, but, more than that, the surface of the ground itself may be altered. Rises in the ground which obstruct the view can be removed while unseen hollows can be filled up. Although this may not be a cheap matter and will not make an imposing show, like a massive fort, its value will be proved in the day of assault. Clearance of the foreground, in the way described, should be the first work of the engineer in permanent as in field fortification, and it may be noted that this will never get "out-of-date" or require modern improvements so long as the particular position has to be held.

The next most important matter would seem to be the provision of the nuclei of the *points d'appui*, or in other words the forts, and with them must be coupled the positions for the guns intended for flanking fire. To make cover proof against the actual hits of modern artillery is a matter requiring a long time. Therefore the erection of the forts seems a work for peace time, while the flanking guns will be so

effective in economizing men that they should be ready and have their fighting positions ready for any emergency.

The provision of the above elements of the defence in peace time should suffice to stop any sudden assault on the ordinary place, and in these days it is difficult to imagine any fortress which could be suddenly attacked, meaning by the word "suddenly," a matter of hours. There will always be time to make some preparations. But the very existence of these works, small though they may be, cannot but have a moral effect which it is impossible to ignore. To the attacker they will act as a deterrent to a greater or less degree, while they will correspondingly encourage the defender. Strategical movements, even, may be affected by their existence.

In addition to these outstanding points other matters can and should be seen to in peace time. Covered communications by road, and if necessary by rail, should be made, belts of woodland can be planted for purposes of concealment, while arrangements for the transmission of intelligence are also best prepared at leisure. In most cases it will be sufficient for the remainder of the defence preparations to be elaborated in a scheme which must be revised periodically. Sites for works must be chosen, designs prepared, communications carefully planned, and all arrangements made for the collection, transport and distribution of men, tools and materials. More details on this subject will be found in *Military Engineering*, Part II., para. 13.

It will be observed that the organization sketched above, although intended to be carried out partly in peace time, can be followed in the case of a purely field fortress with modifications in matters of details and materials, thus bearing out the contention that permanent fortification is approximating to field.

The design of the forts has been touched on incidentally only, and within certain limits there are many designs which fulfil the desiderata. It will be sufficient here to mention the principal points which it would seem should be attended to in the design of a fort, but the actual details may well be left to be decided according to the local circumstances. A stereotyped design for a work of this kind is never satisfactory.

Omitting consideration of the flanking fire guns which have already been dealt with (see also *Military Engineering*, Part II., *Plate* II., for a provisional work including these guns), the requisites of a fort would appear to be :—

(*a*). Garrison, stores of all kinds, water, kitchens, latrines and drainage.
(*b*). All-round field of fire.
(*c*). Facilities for the use of weapons.
(*d*). Cover from the enemy's fire.
(*e*). Communications both internally and with the outside.
(*f*). Obstacle.
(*g*). Ample material for the repair of the damage caused by the enemy's fire.

Dealing with these separately :—

(*a*). Remarks on this subhead are almost superfluous except that naturally the stores, etc., must all be protected from the enemy's fire. The thickness of the protecting medium will depend upon the position of the fortress and its probable enemies.

(*b*). If the fort be in the rearward position, it will generally be fairly easy to arrange for a clear field of fire. The flanks should not be short, since the value of a closed work is that it can make itself felt all round the circle and no one face is easier to attack than another.

(*c*). A fort is an infantry work by hypothesis, and the parapet must be arranged for infantry fire all round. This may have to be delivered under hostile fire which may consist of rifle bullets, common (including high explosive) shell or shrapnel. As already pointed out, the chances of many hits by common shell on the line of firing infantry will not be great, but shrapnel, unless guarded against, can prevent the garrison of the fort manning their parapets. Therefore this must be reckoned with, and the infantry parapet must be traversed and provided with head cover and overhead cover. It will be found that this can be arranged with greater ease, by putting the rifle line in the middle of the parapet than at its rear edge. It then becomes practically a fire trench in the mass of earth forming the parapet. This is recommended by Capt. von Schwartz, one of the Russian engineers at the Siege of Port Arthur. Should the fort be subjected to very heavy bombardment of an accurate character followed by immediate assault, the defenders will be no worse off if their firing line has been placed as suggested rather than at the rear edge ; if the whole parapet has become a shapeless mass, they can still lie down on the remains of the rear edge, and they could have done no better in any case. This is to assume the worst case, and it is quite possible and even probable that portions of the firing line will still be in existence at the end of the bombardment, and then the value of the overhead cover will be reaped.

d). While the fort is being bombarded, and this will certainly occur wherever it is sited, the garrison must keep in their casemates. The thickness of the roofs will be determined, as in the case of the stores, by the nature of the probable artillery to be brought against them. It should suffice if the protection is a little more than enough to keep out one shell, two shells landing on the same spot will have to be risked.

(*e*). It stands to reason that covered communications are necessary throughout the fort to allow rapid manning of the parapet and reinforcement of threatened points. The protection should be equal to that of the casemates. Underground telegraphic or telephonic wires to the rest of the fortress are almost essential, while a covered way up to the rear of the fort will be of the greatest value.

(*f*). The obstacle has already been mentioned—a well-flanked deep ditch.

(*g*). At every available opportunity the garrison should endeavour to repair the damage caused by the enemy's fire. For this purpose an ample supply of tools, sand-bags and other revetting materials, timber, etc., should be at hand, and a store of loose earth or, better still, sand should be kept in the fort in an easily accessible spot.

Many forts could be designed fulfilling all these conditions and their details might differ considerably. But variations in detail are of small account in fortification and have often proved its curse. Principles are the primary consideration. As one of the older masters of the art puts it, "Fortification requires simplicity and strength. It is not on a few little contrivances carefully hidden that one can rely for a good defence. Small means produce small results."

ADDENDUM.

For those who desire to have a more detailed knowledge of modern permanent fortification the following books are recommended :—

Fortification, by Sir Geo. Clarke, G.C.M.G. (2nd edition).

Fortification article in *Encyclopædia Britannica*, 11th edition, by Colonel L. C. Jackson, C.M.G.

British Official History of Russo-Japanese War, Part III.

Fortification Cuirassée, by Colonel Piarron de Mondesir.

Influence of Port Arthur on the Construction of Modern Fortresses, by Capt. von. Schwartz.

Fortification depuis le temps de Vauban, by General A. Brialmont.

Manuel de Fortification, 1909 edition, by Legrand-Plessix.

Permanent Fortification, 7th edition, by Major von Brunner. Official English translation.

PLATE I.

River Conway
CASTLE
LE STREET
St Mary's Church
ROSEHILL STREET
L. N. W. R.
HIGH
LANCASTER SQUARE
Railway Station
ROAD
UPPERGATE STREET
ROSEMARY LANE

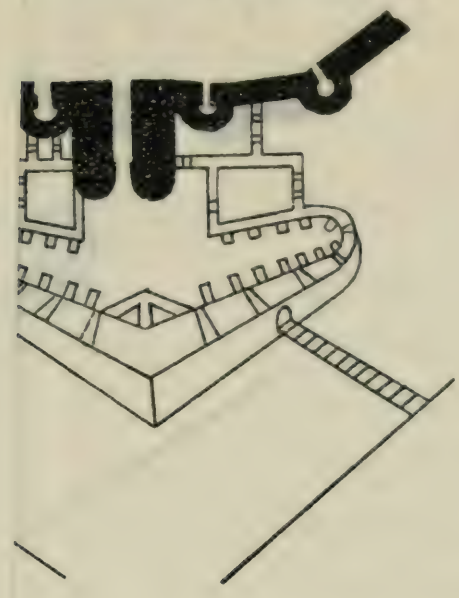
PLATE I.

CONWAY
in 1901
Scale
from a plan by F. Delamotte, Esq.
River Conway
CASTLE
WHARF
LOWERGATE ST.
CASTLE STREET
BERRY STREET
ROSEHILL STREET
St. Mary's Church
HIGH STREET
CHAPEL STREET
LANCASTER SQUARE
ROSEMARY LANE
UPPERGATE STREET
BANGOR ROAD
L. N. W. R.

F THE ST. JACQUES GATE,
)YES. A.D. 1524.

Militaire" by Viollet-le-Duc

Fig. 1



NICK-UPON-TWEED.

Fig 2

BOULEVARD OF THE ST. JACQUES GATE, TROYES. A.D. 1524.

From "L'Architecture Militaire" by Viollet-le-Duc

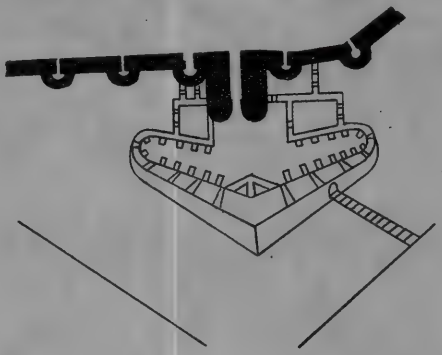
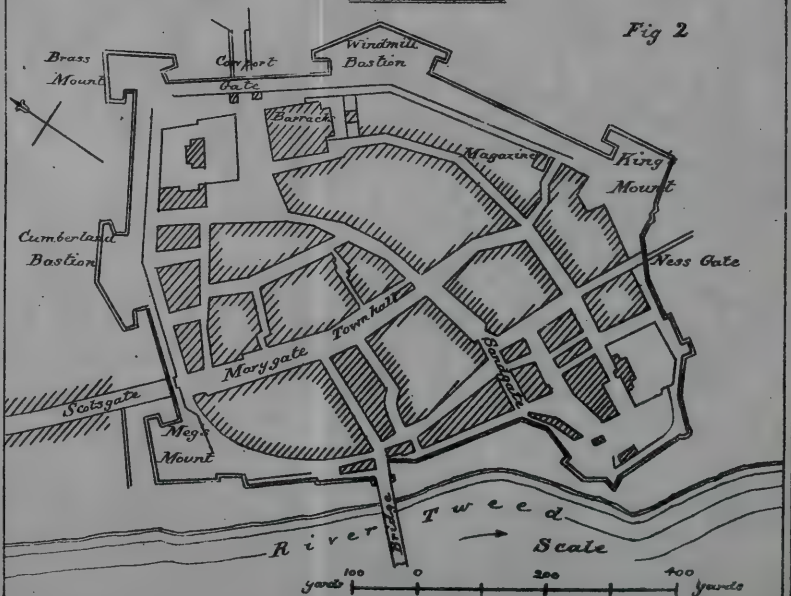


Fig. 1

BERWICK-UPON-TWEED.

Fig 2



CHATHAM.

Brompton Lines

…tructed 1778

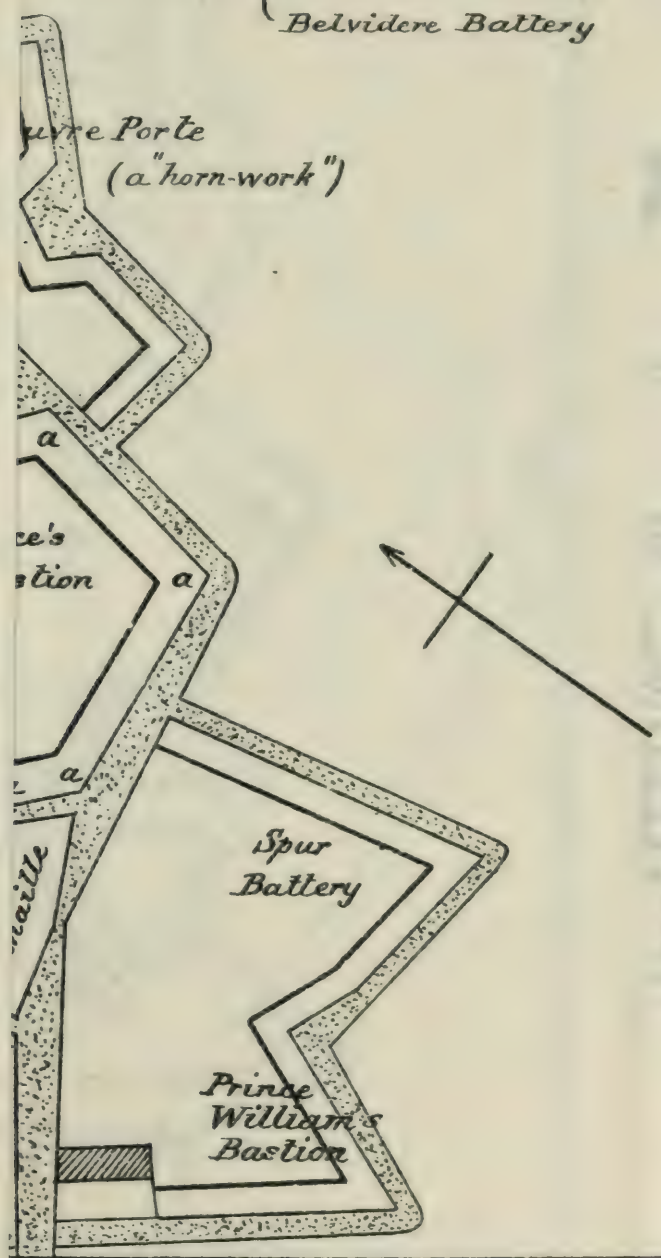
Scale

100 200 yards

Main line a a a, &c.

Outworks { *Couvre Porte* / *Spur Battery* / *Prince William's Bastion*

…trenchments { *Rear of Prince's Bastion* / *Amherst Redoubt* / *Belvidere Battery*



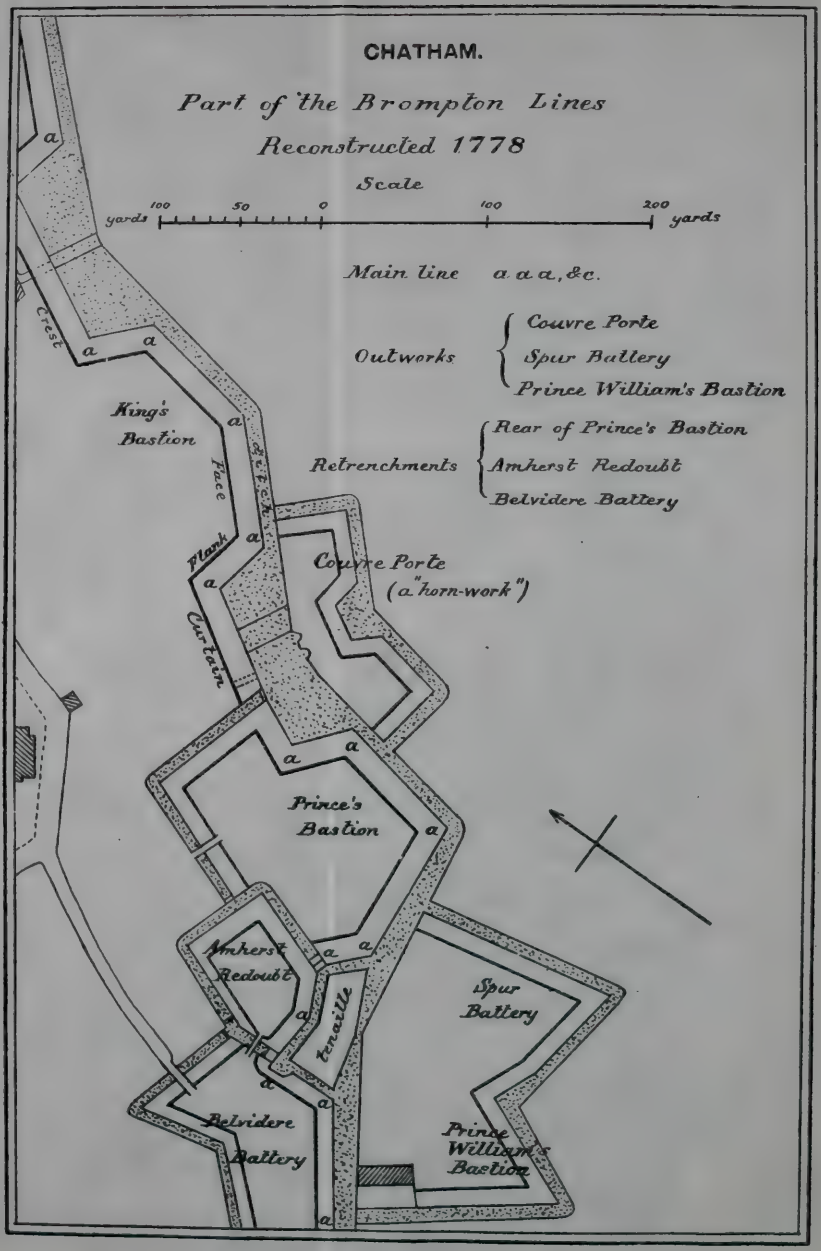
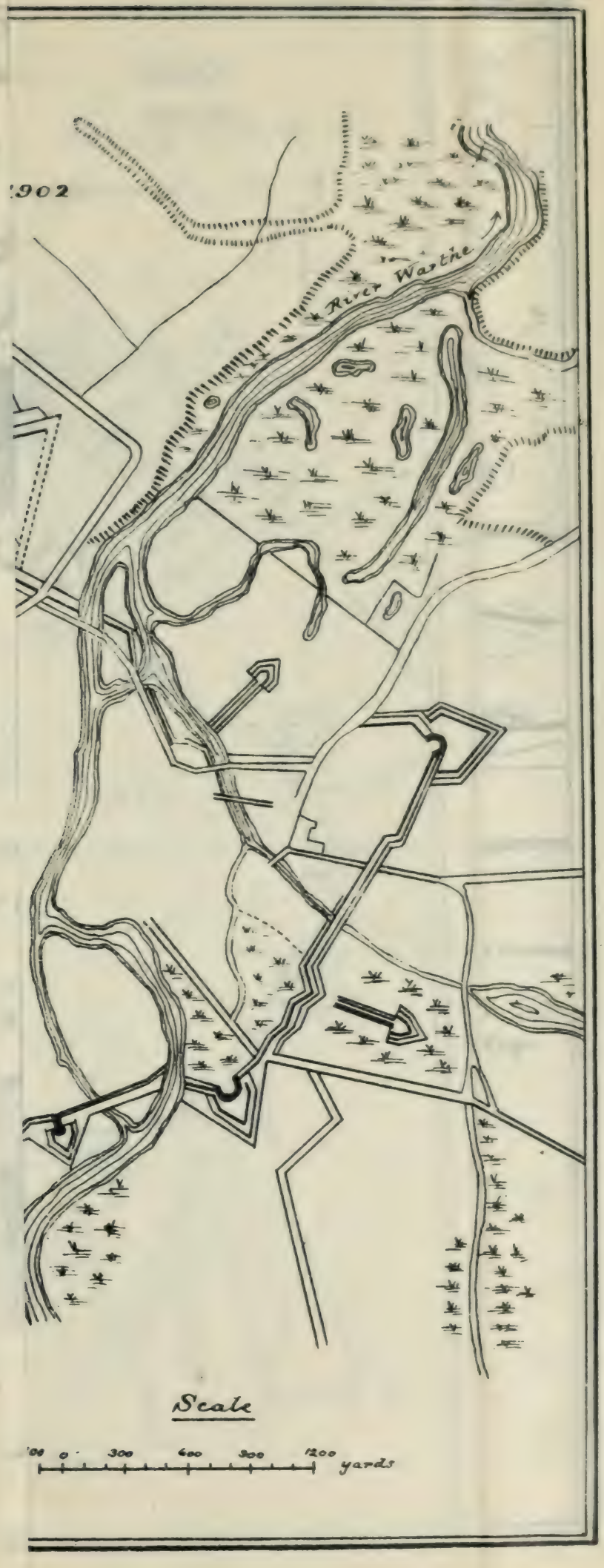

CHATHAM.
Part of the Brompton Lines
Reconstructed 1778
Scale
yards 100 50 0 100 200 yards
Main line a a a, &c.
Outworks
Couvre Porte
Spur Battery
Prince William's Bastion
Retrenchments
Rear of Prince's Bastion
Amherst Redoubt
Belvidere Battery
King's Bastion
Face
Flank
Curtain
Couvre Porte
(a "horn-work")
Prince's Bastion
Amherst Redoubt
Traille
Spur Battery
Belvidere Battery
Prince William's Bastion
Crest
a

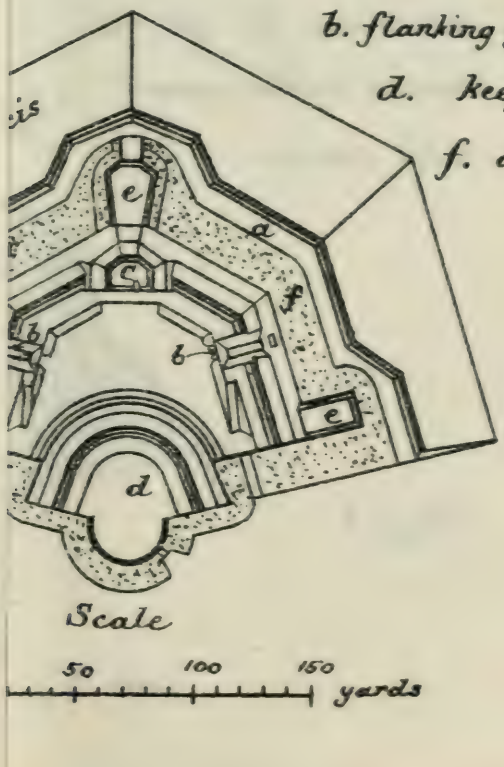
PLATE IV.

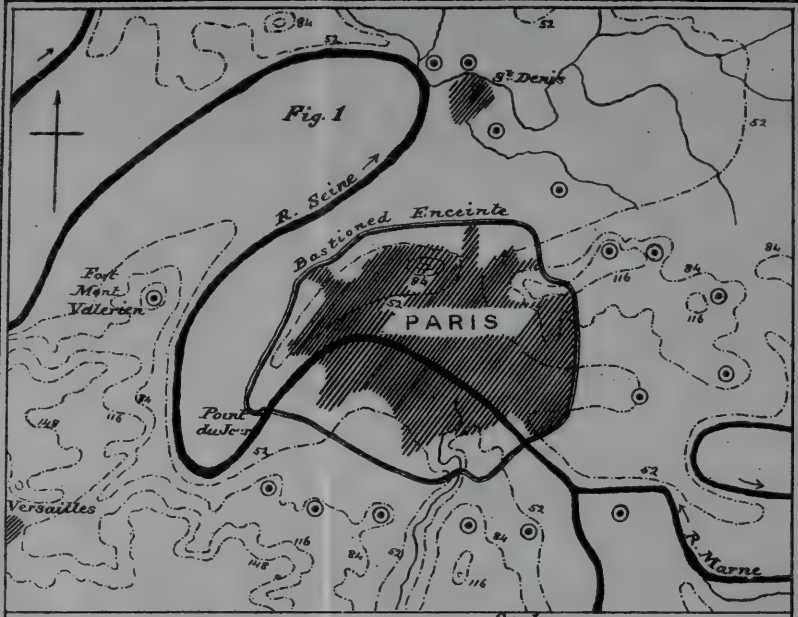


POSEN.
Fortified in 1828
Enceinte demolished in 1902
River Warthe
Town
of
Posen
Scale
yards 100 0 300 400 800 1200 yards

PLATE V.

FORT AT COLOGNE





DETACHED FORT AT COLOGNE

a. covered way for rifle fire
b. flanking gun in Haxo casemate
c. Cavalier 3' above parapet
d. keep
e. ditch caponier
f. ditch 20' deep

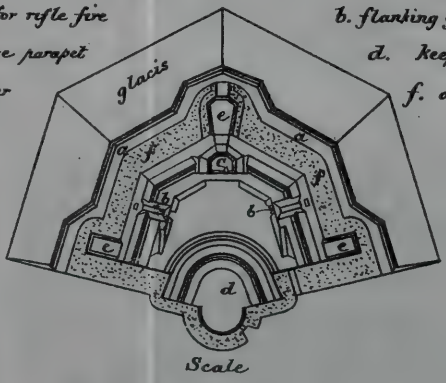


Fig. 2

Scale
yards
10 0 50 100 150
yards

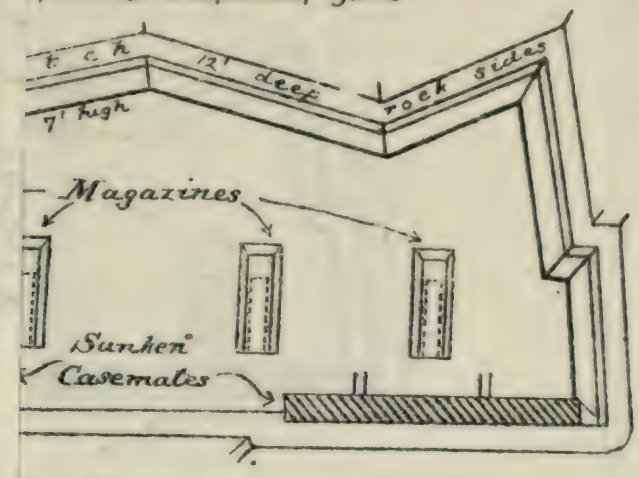
LFORT, 1870.

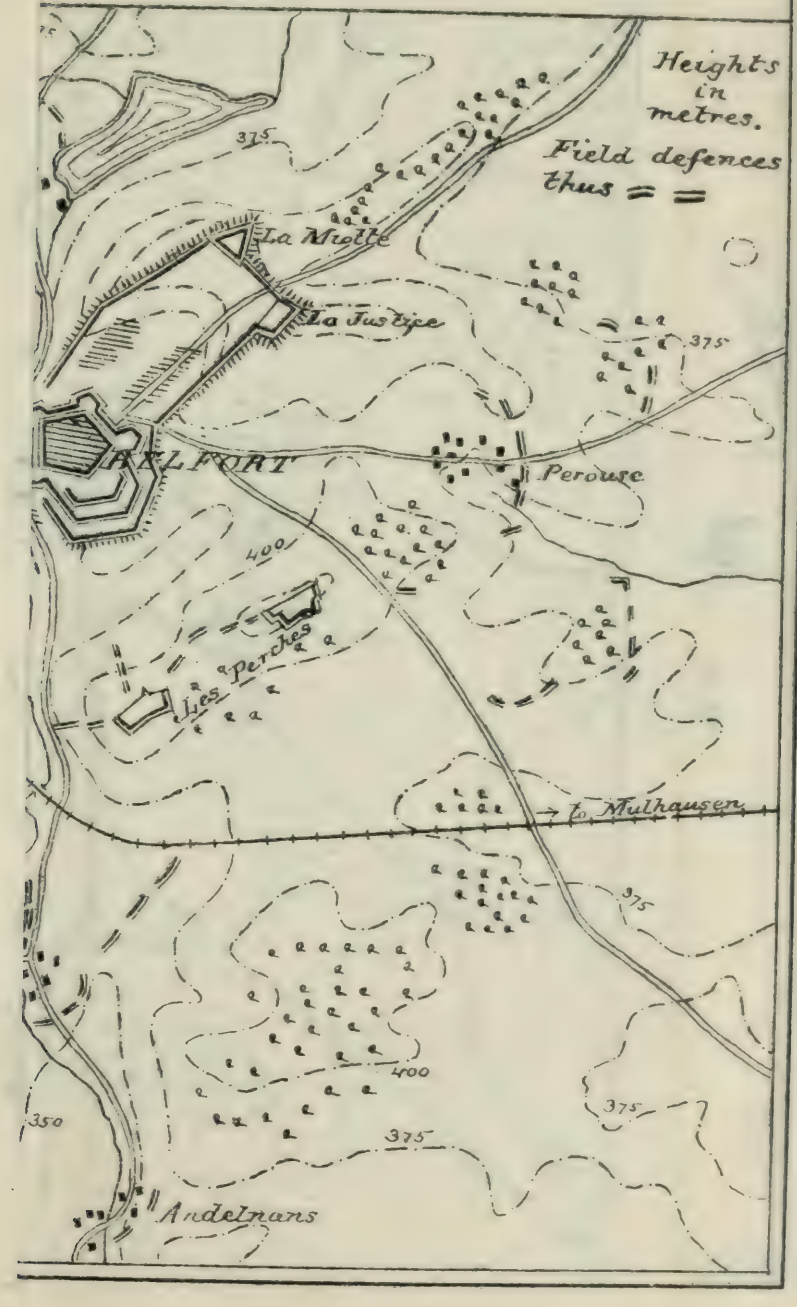
le for Plan

1 2 mile

Perches Redoubt

Scale 50 100 yards





BELFORT, 1870.

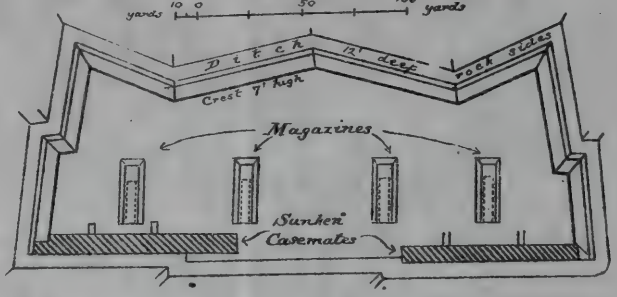
Scale for Plan

yards 200 0 — ½ — 1 — 2 mile

Haute Perches Redoubt

Scale

yards 10 0 — 50 — 100 yards



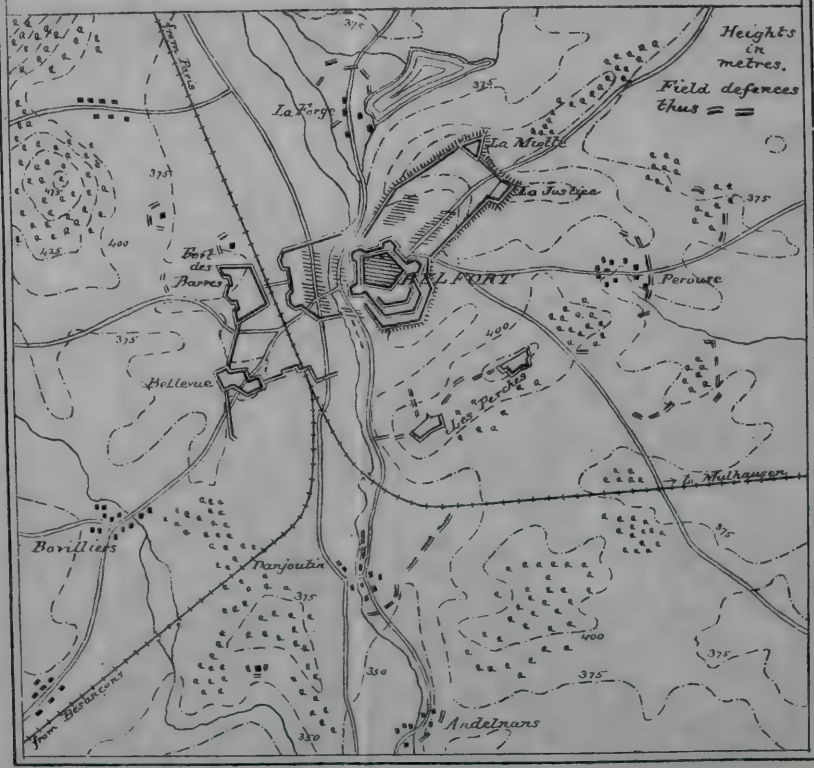


PLATE VII.

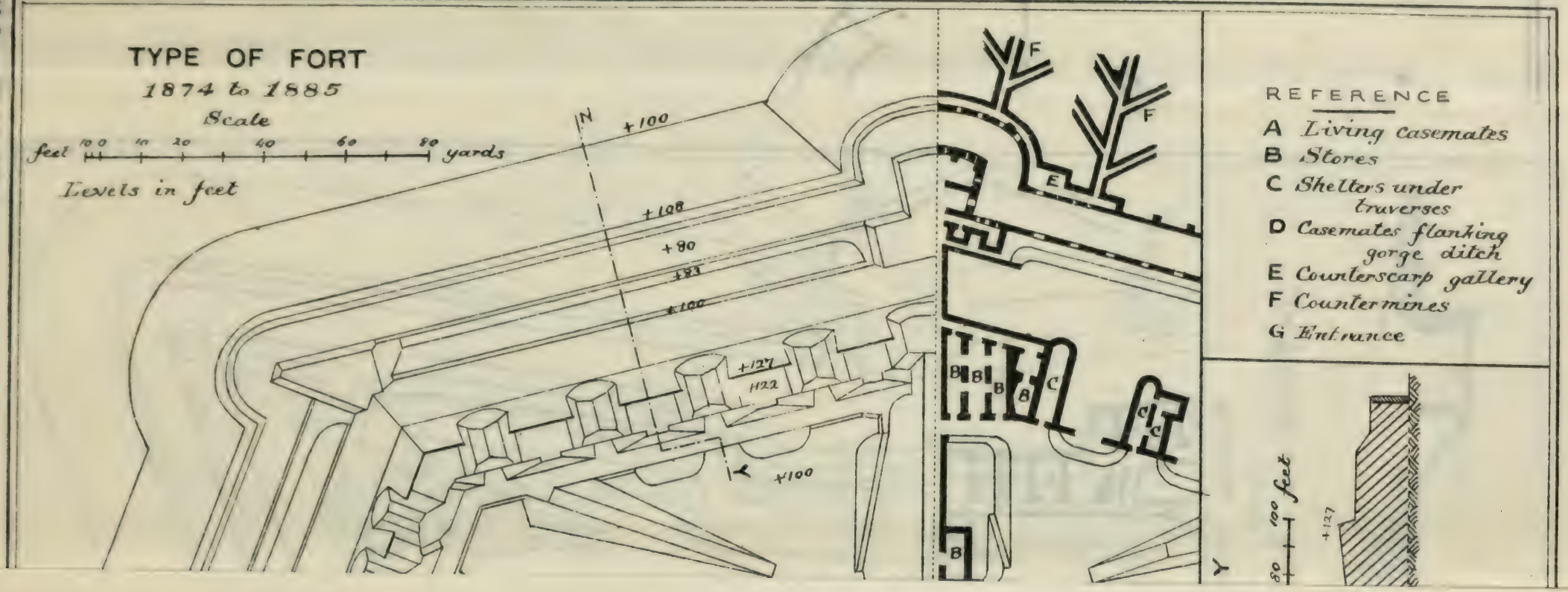
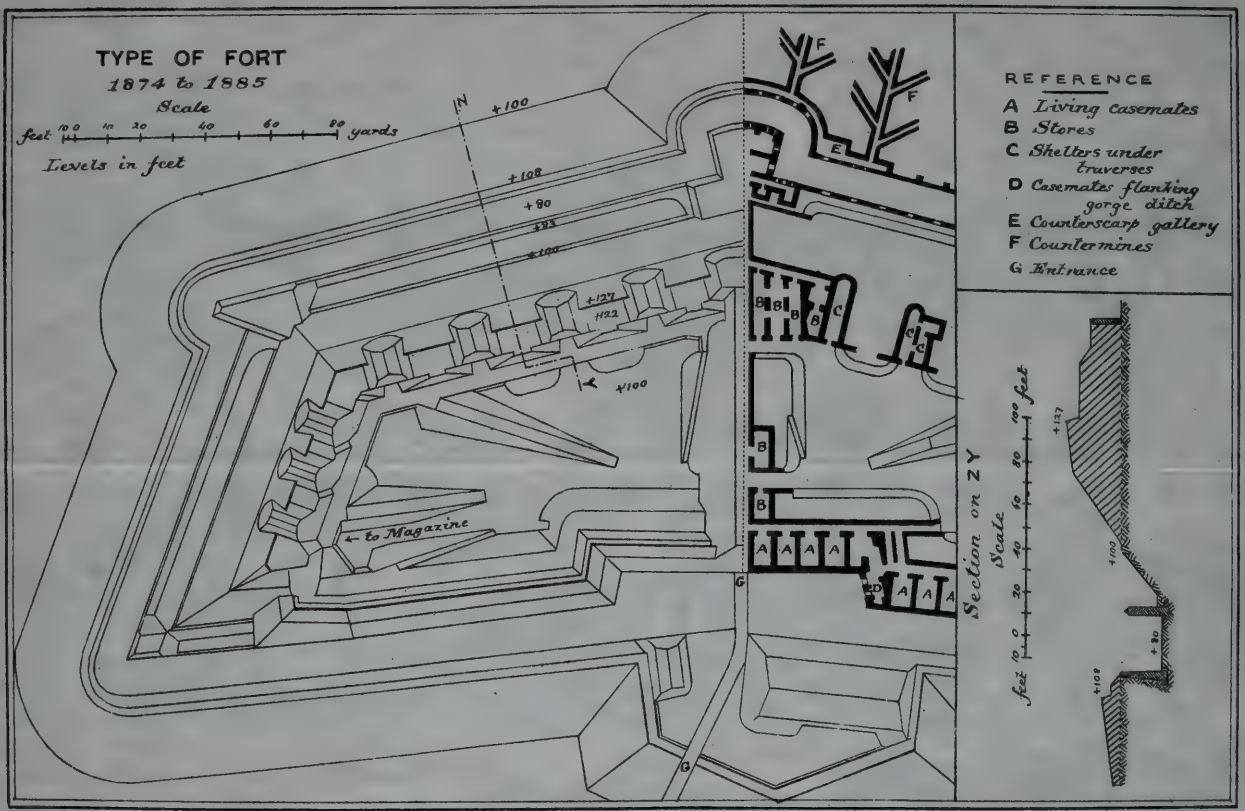
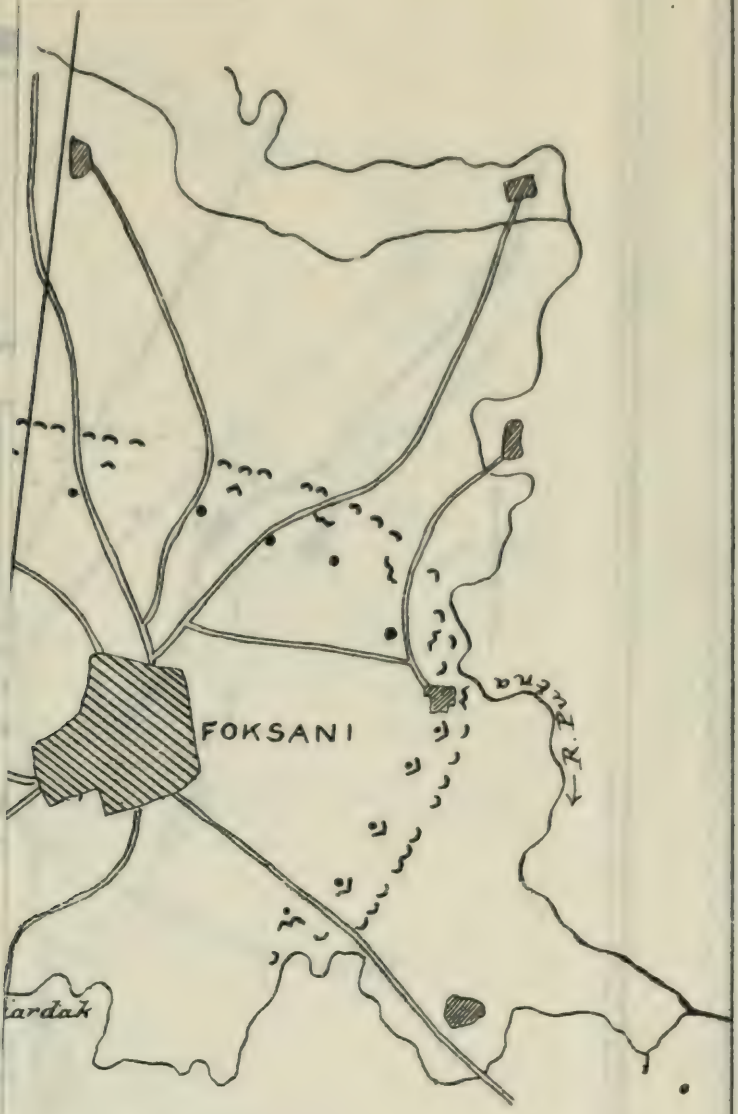

TYPE OF FORT
1874 to 1885
Scale
feet 100 0 10 20 40 60 80 yards
Levels in feet
N
+100
+108
+80
+83
+100
+127
+122
+100
F
F
E
B
B
B
B
C
C
C
B
REFERENCE
A Living casemates
B Stores
C Shelters under traverses
D Casemates flanking gorge ditch
E Counterscarp gallery
F Countermines
G Entrance
Y
80 100 feet
+127

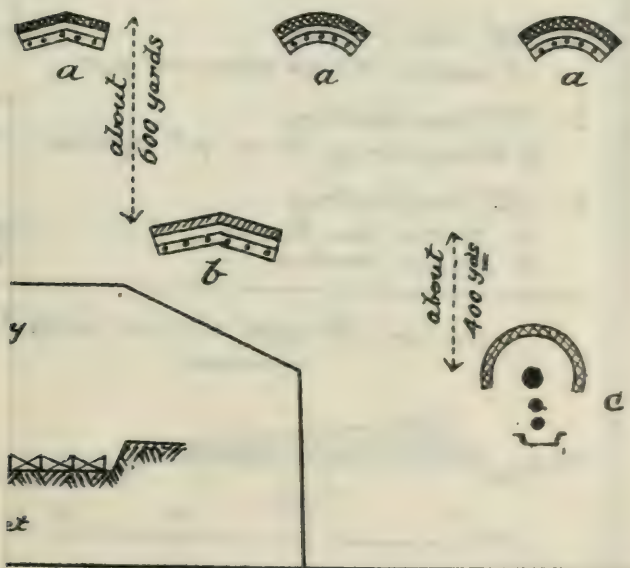
PLATE VII.


TYPE OF FORT
1874 to 1885
Scale
feet 10 0 10 20 40 60 80 yards
Levels in feet
N
+100
+108
+80
+93
+100
+127
+122
+100
to Magazine
REFERENCE
A Living casemates
B Stores
C Shelters under traverses
D Casemates flanking gorge ditch
E Counterscarp gallery
F Countermines
G Entrance
Section on ZY
Scale
feet 10 0 20 40 60 80 100 feet
+127
+100
+80
+100

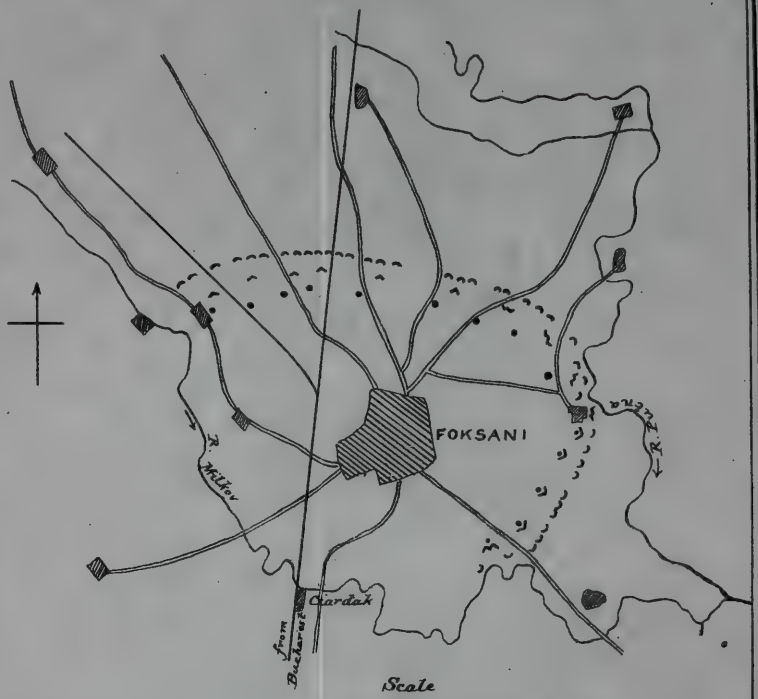
NES OF SERETH.



Works in Sereth Lines
(not to scale)



THE LINES OF SERETH.



Group of Works in Sereth Lines
(not to scale)

a 1st line battery
5 mobile 3·7-cm armoured Q.F.

b. 2nd line battery
6 disappearing 5·3 cm Q.F. cupolas

c 3rd line battery
1 12-cm gun turret
2 12-cm. mortars

Section through 1st line battery

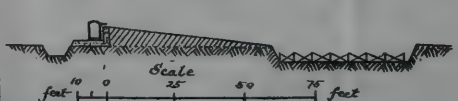
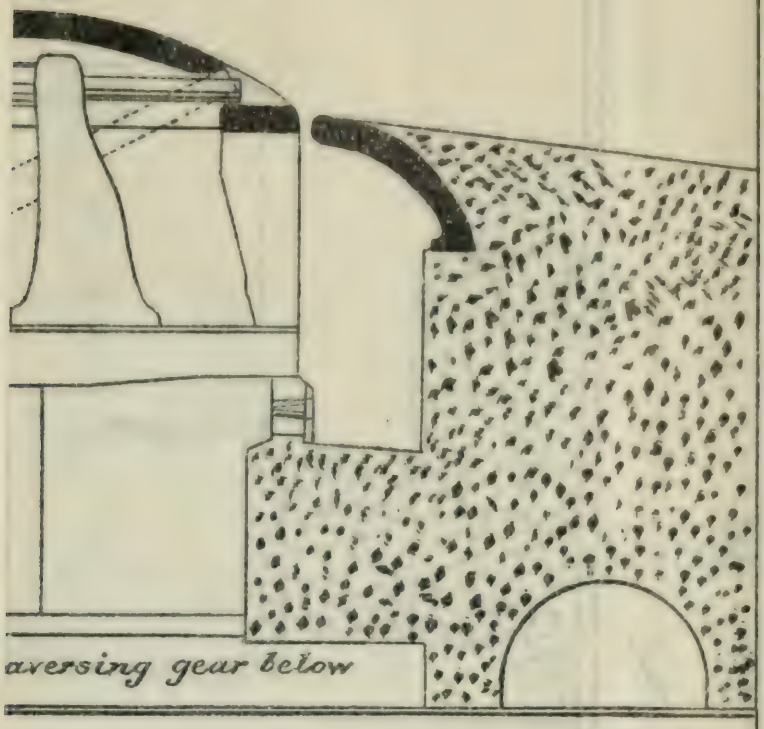
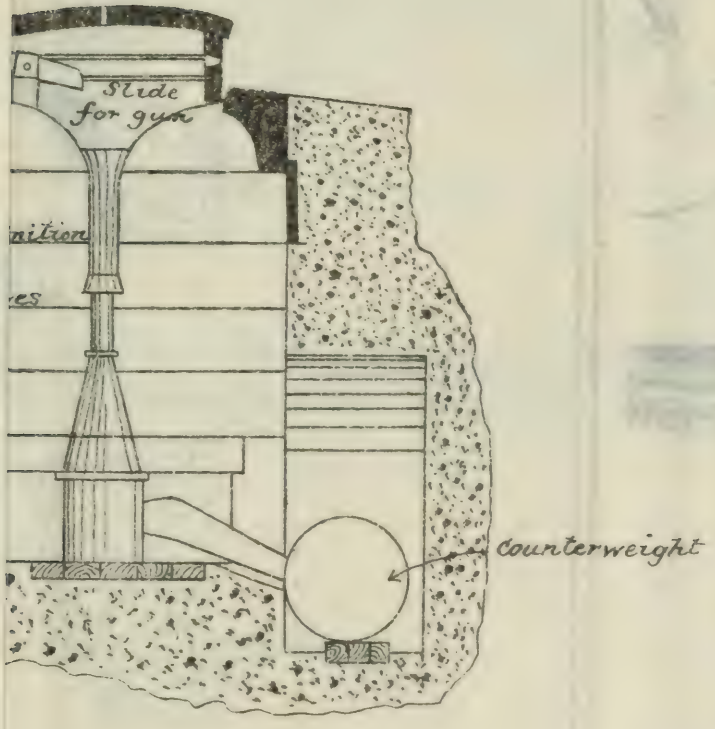


PLATE IX.

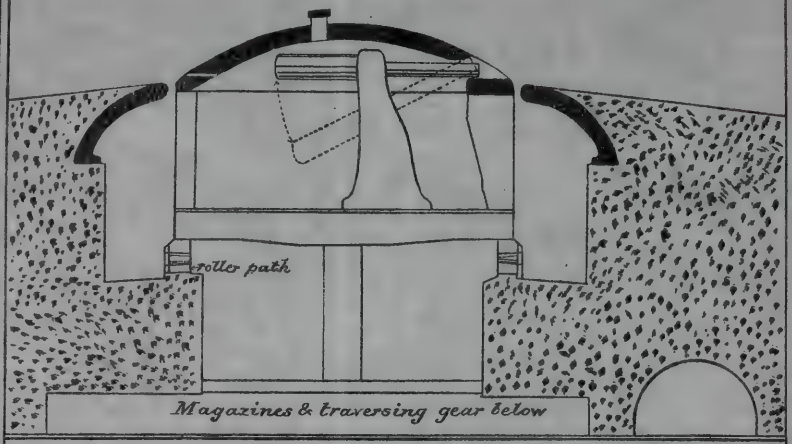
TWO 5-INCH GUNS.



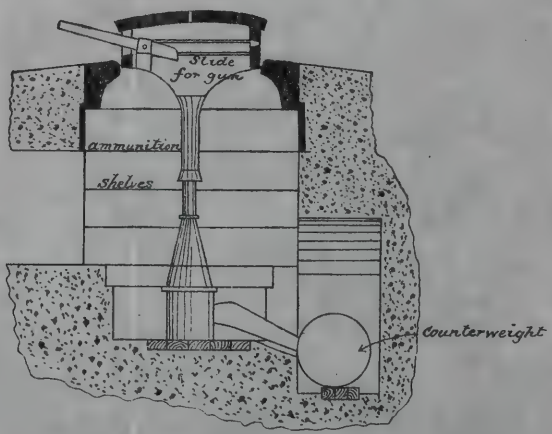
CUPOLA FOR 2·25" GUN



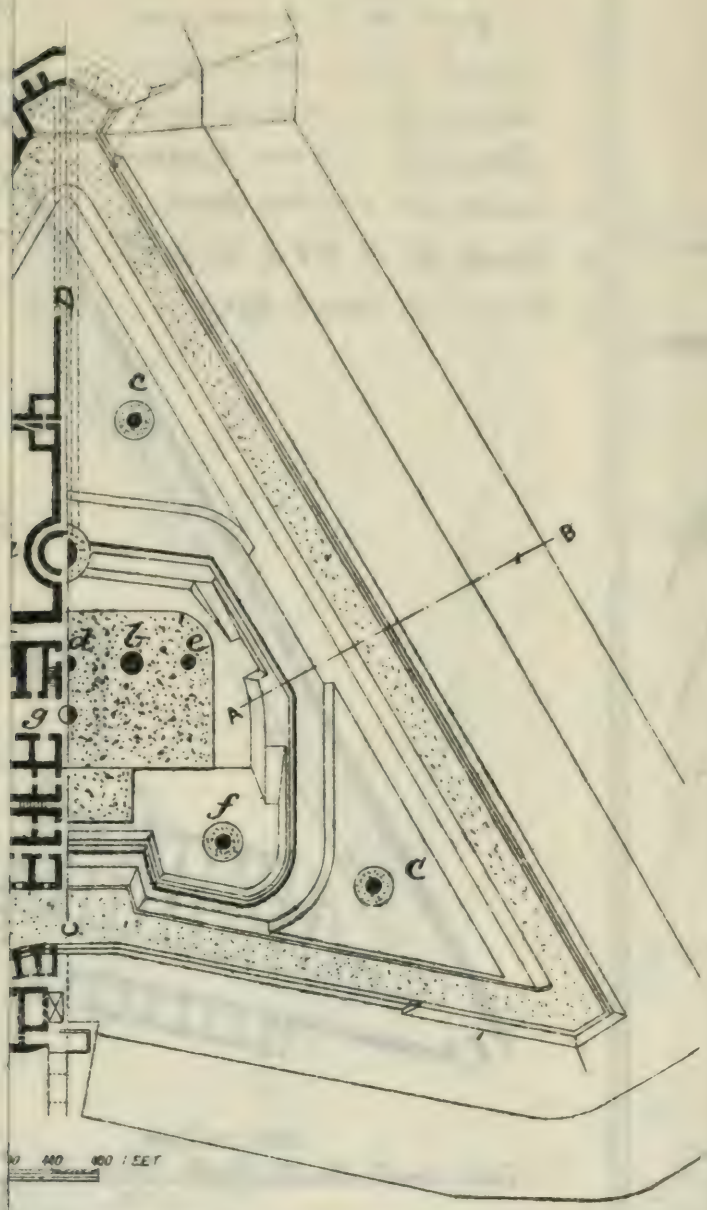
CUPOLA FOR TWO 5-INCH GUNS.



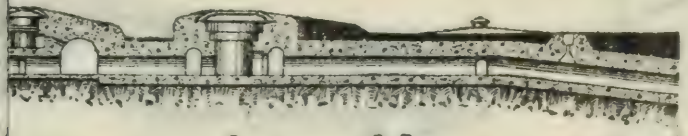
DISAPPEARING CUPOLA FOR 2·25" GUN



, LIEGE AND NAMUR.



r plan



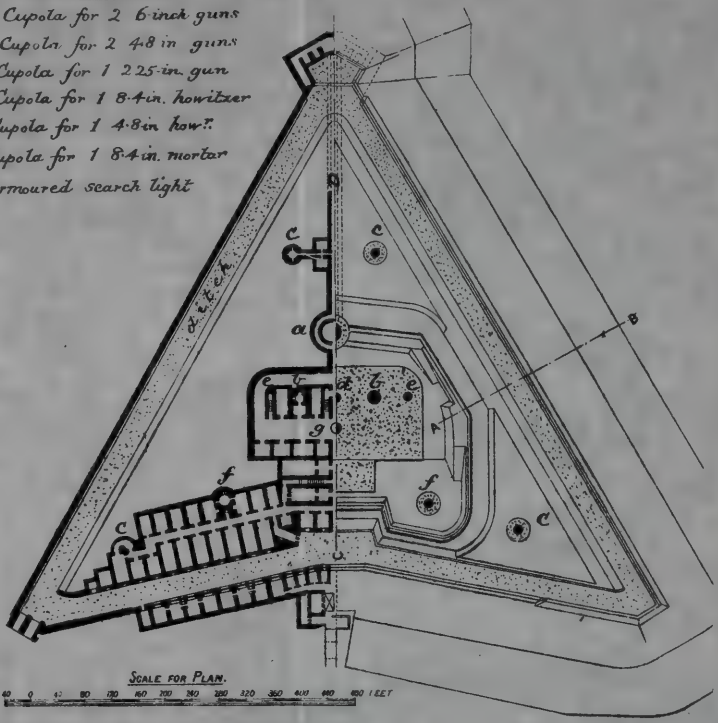
SECTION C.D.

ECTION A.B.

TYPE OF FORT, LIEGE AND NAMUR.

REFERENCE.

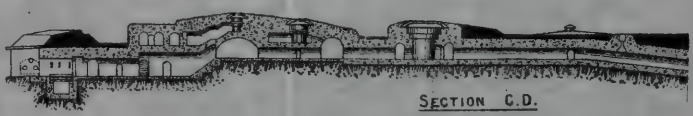
a. Cupola for 2 6-inch guns
b. Cupola for 2 4·8 in guns
c. Cupola for 1 12·5-in. gun
d. Cupola for 1 8·4 in. howitzer
e. Cupola for 1 4·8 in howr.
f. Cupola for 1 8·4 in. mortar
g. Armoured search light



SCALE FOR PLAN.

FEET 40 0 40 80 120 160 200 240 280 320 360 400 440 480 FEET

Scale for sections double that for plan



SECTION C.D.

SECTION A.B.

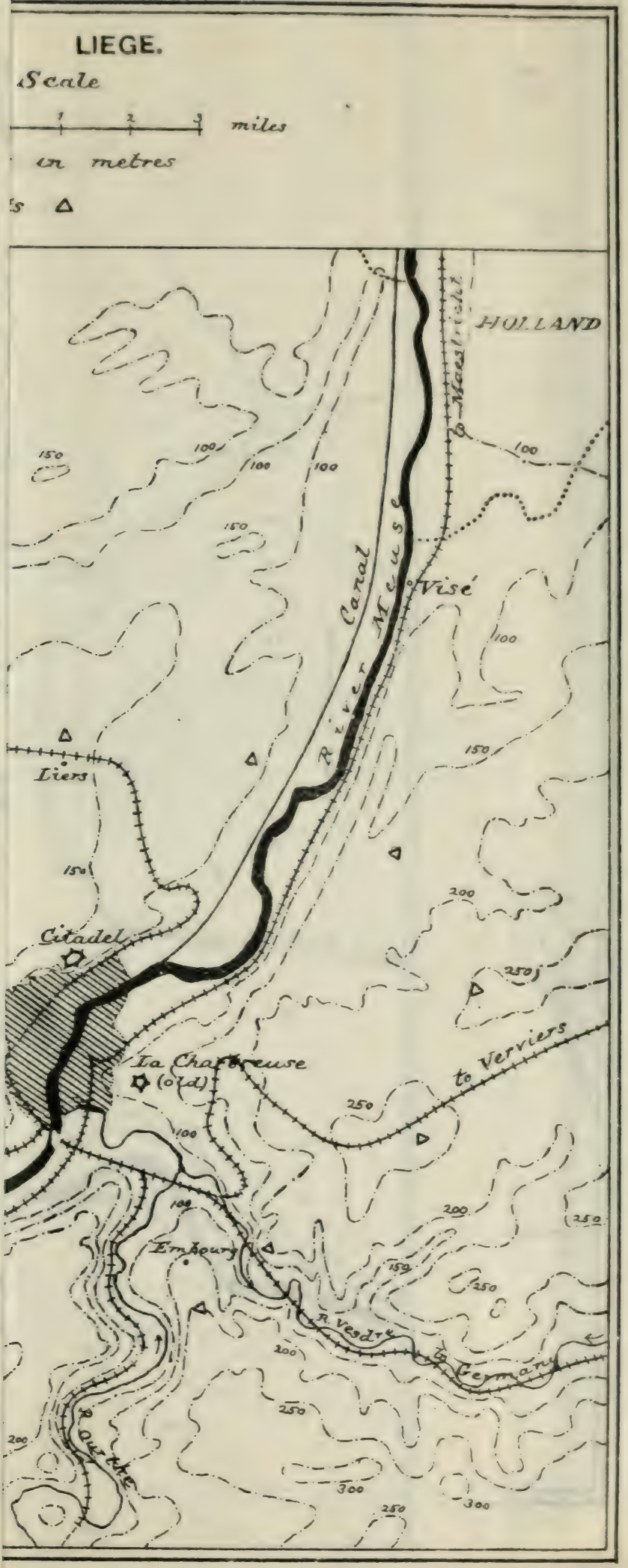

LIEGE.
Scale
1 2 3 miles
in metres
HOLLAND
River Meuse
Canal
Visé
Liers
Citadel
La Chartreuse
(old)
to Verviers
Embourg
R. Vesdre
Germany
R. Ourthe
100
150
200
250
300

PLATE XI.

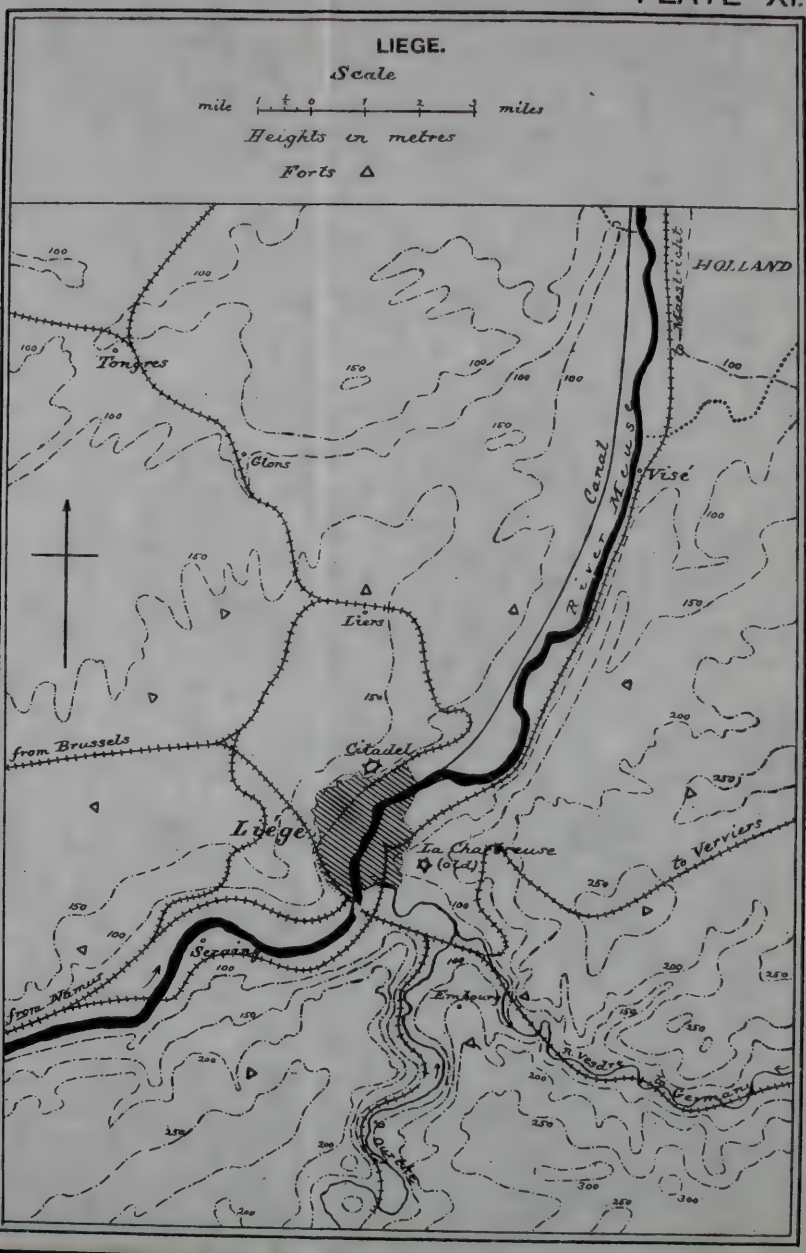
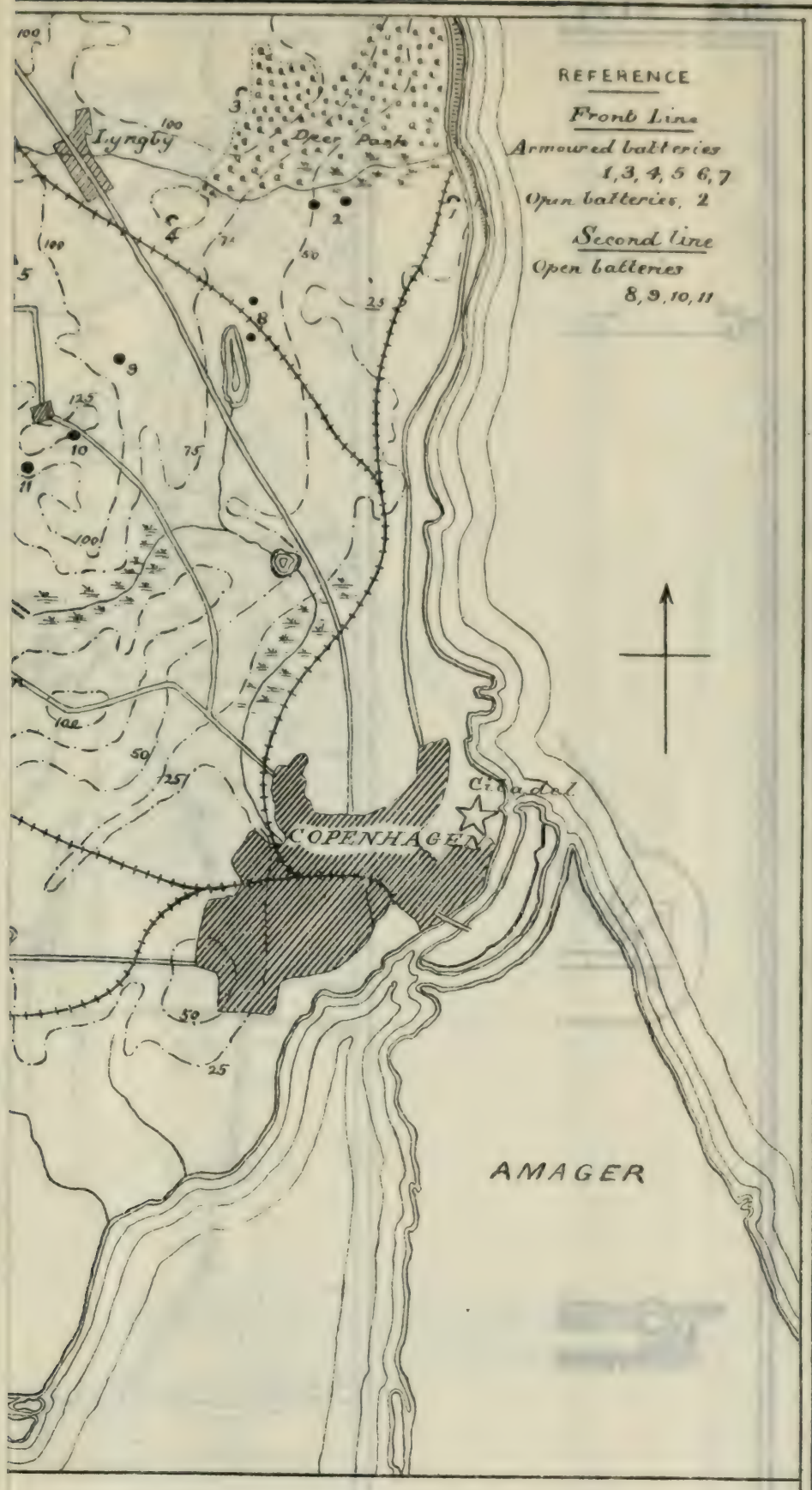

LIEGE.
Scale
mile
miles
Heights in metres
Forts
HOLLAND
Tongres
Glons
Visé
River Meuse
Canal
Liers
from Brussels
Citadel
Liége
La Chartreuse
(old)
to Verviers
Seraing
from Namur
Embourg
Vesdre
Laveux
Sauvenière

PLATE XII.



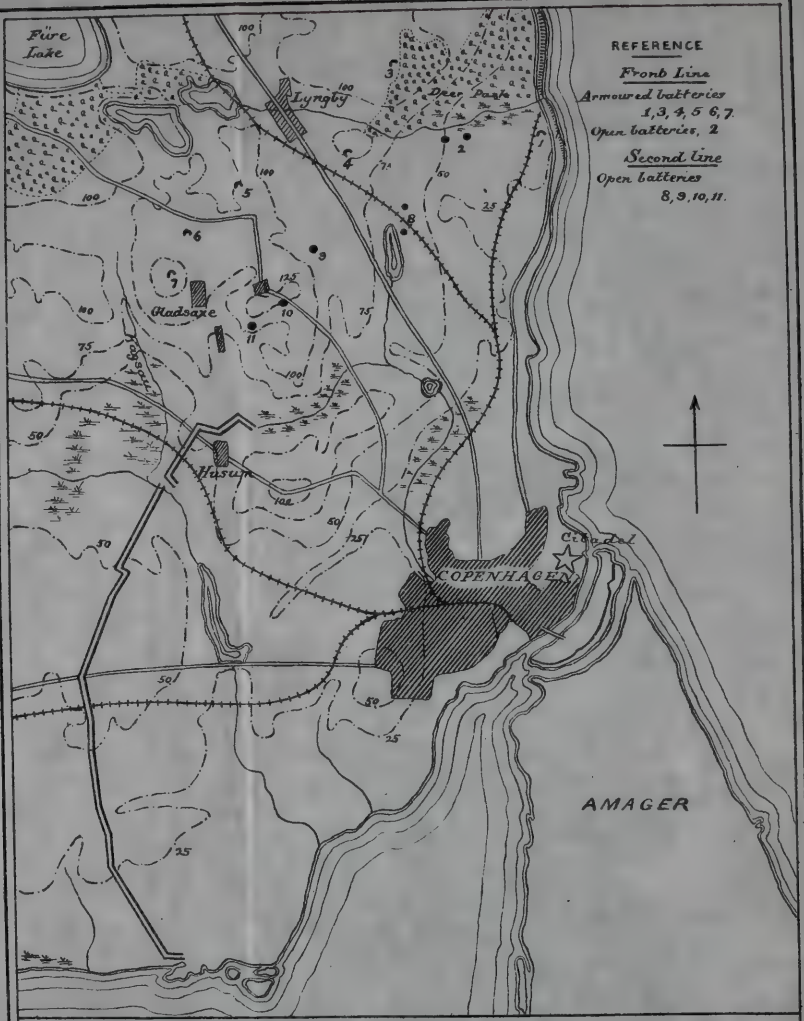
LAND DEFENCES, COPENHAGEN.

Scale

½ 0 1 2 3 4 miles

Heights in feet

PLATE XII.



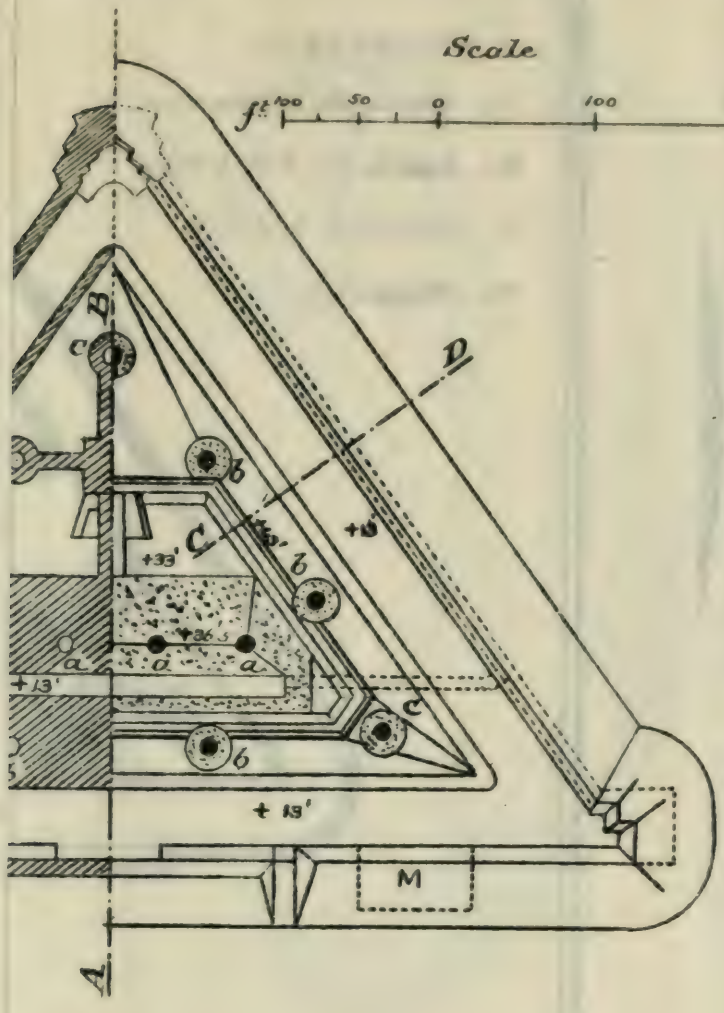
LAND DEFENCES,
COPENHAGEN.

Scale

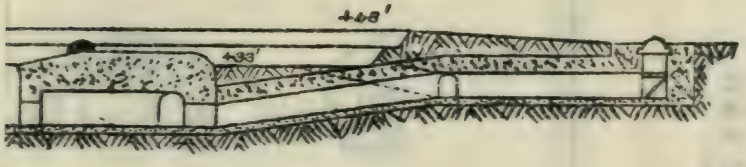
mile 1 ½ 0 1 2 3 4 miles

Heights in feet

AISER WILHELM II.,
MOLSHEIM.

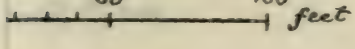


ion on AB



n on CD

le for Sections



FORT KAISER WILHELM II., MOLSHEIM.

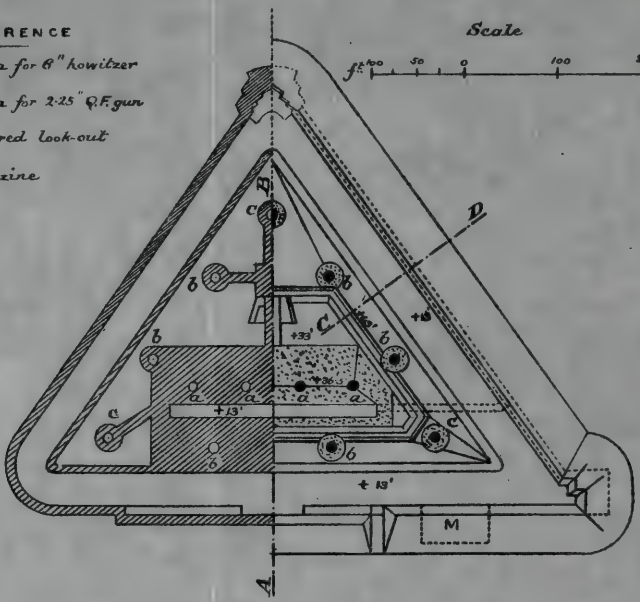
REFERENCE

a. cupola for 6" howitzer

b. cupola for 2·25" Q.F. gun

c. armoured look-out

M. magazine



Section on AB

Section on CD

Scale for Sections

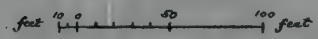
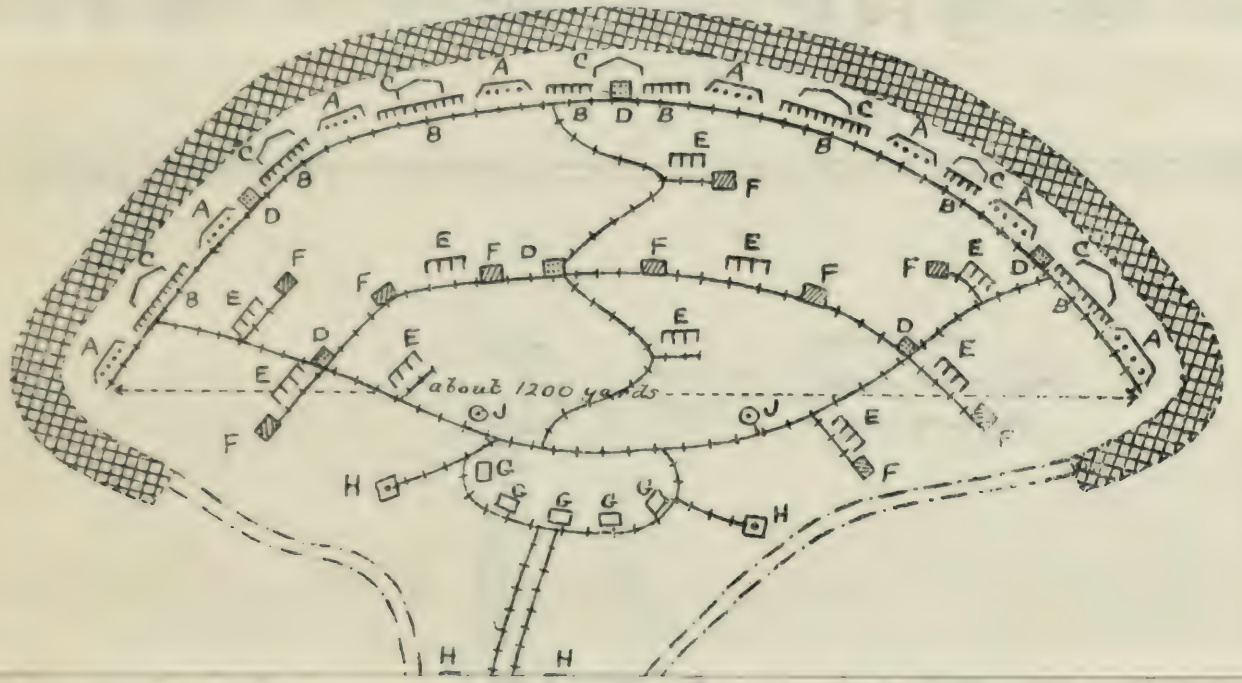


PLATE XIV.

DIAGRAM OF A FORT

from "Les Forts et la Mélinite" by "Un pionnier"



REFERENCE

A — *Batteries for "safety" armament*

B — *Alternative emplacements*

C — *Infantry works*

D — *Stores depots*

E — *Indirect fire batteries*

F — *Shelters for men*

G — *Bombproofs*

H — *Magazines*

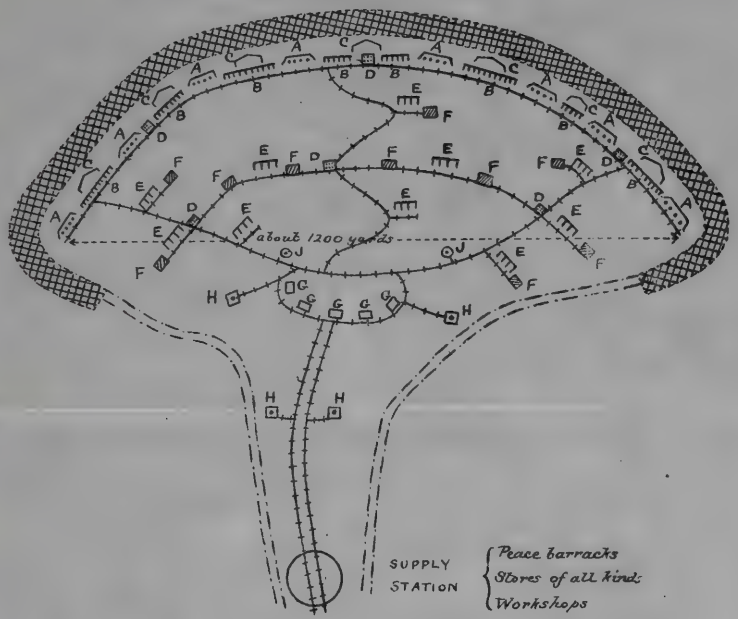
J — *Look-out stations*

Wire entanglement

PLATE XIV.

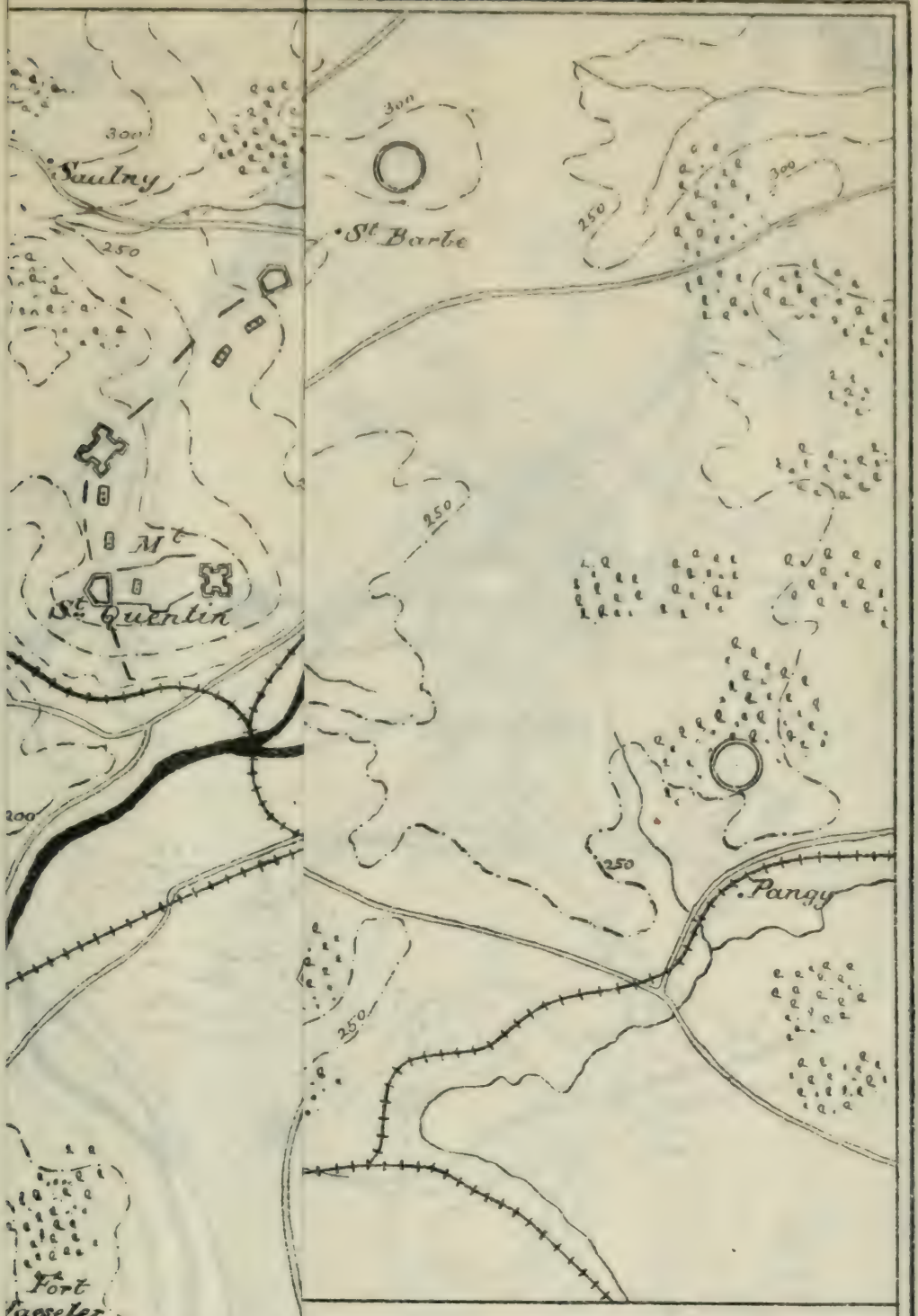
DIAGRAM OF A FORT

from "Les Forts et la Mélinite" by "Un pionnier"



REFERENCE

- A — Batteries for "safety" armament
- B — Alternative emplacements
- C — Infantry works
- D — Stores depots
- E — Indirect fire batteries
- F — Shelters for men
- G — Bombproofs
- H — Magazines
- J — Look-out stations
- Wire entanglement
- Light railway
- Retrenchments



WORKS AT METZ.

de

1 2 miles. Contours 50 metres V.I.

eference

cted prior to 1870

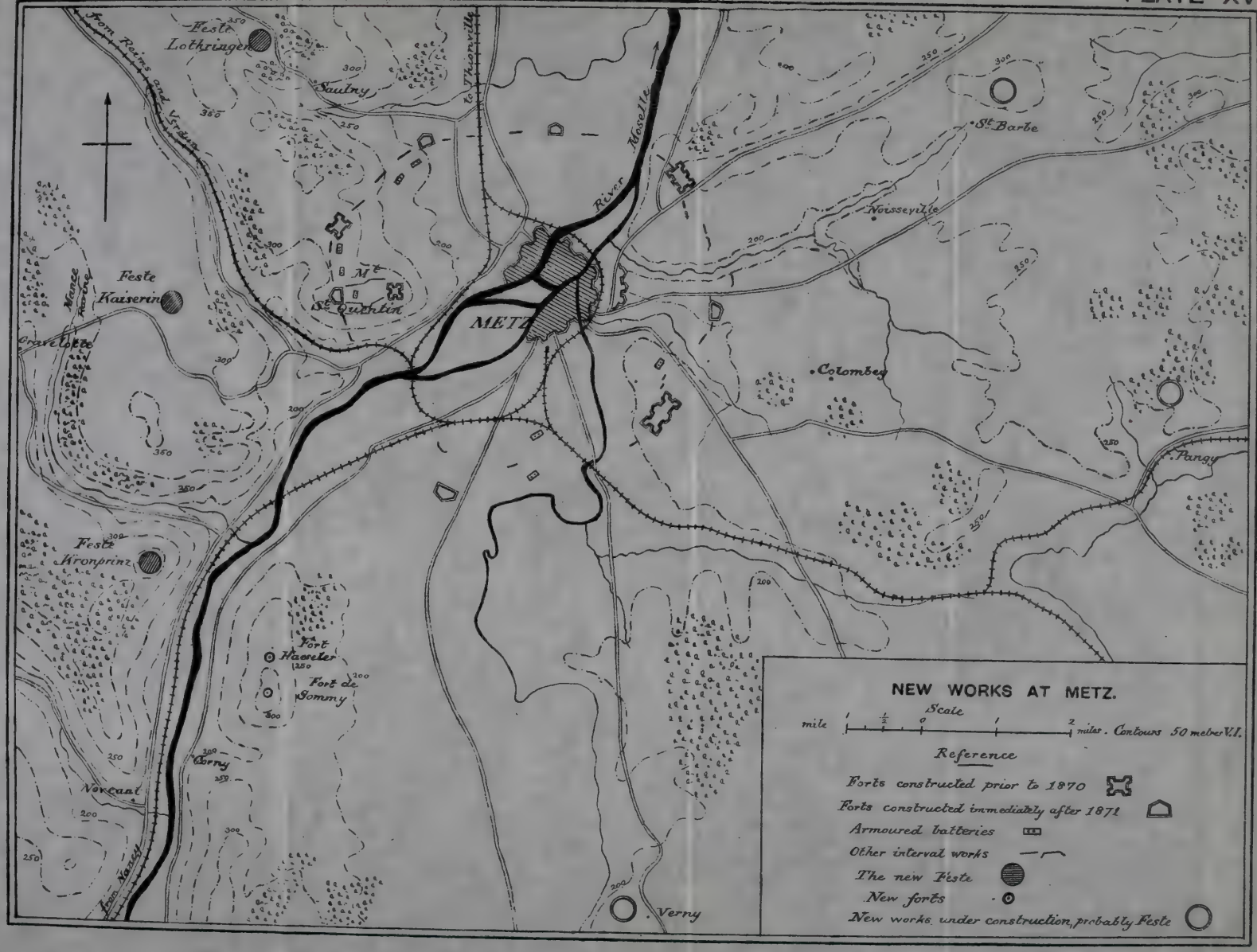
ed immediately after 1871

tteries

works

este

nder construction, probably Feste


From Reims and Verdun
Feste Lothringen
Saulny
to Thionville
River Moselle
St Barbe
Noisseville
Feste Kaiserin
Mance Ravine
Mt St Quentin
METZ
Gravelotte
Colombey
Panay
Feste Kronprinz
Fort Haeseler
Fort de Jommy
Verny
Norcaat
Ton Nancy
NEW WORKS AT METZ.
Scale
mile
2 miles. Contours 50 metres V.I.
Reference
Forts constructed prior to 1870
Forts constructed immediately after 1871
Armoured batteries
Other interval works
The new Feste
New forts
New works under construction, probably Feste

TE DIAGRAM OF THE METZ FESTE.

Reference.

h ana armoured light Q.F. and machine guns ... ... *A*

or direct-fire guns ... ...

APPROXIMATE DIAGRAM OF THE METZ FESTE.

Reference.

Fort, with deep ditch and armoured light Q.F. and machine guns .... *A*

Armoured battery for direct-fire guns .... *B*

Armoured battery for indirect-fire guns .... *C*

Bombproof shelters .... *D*

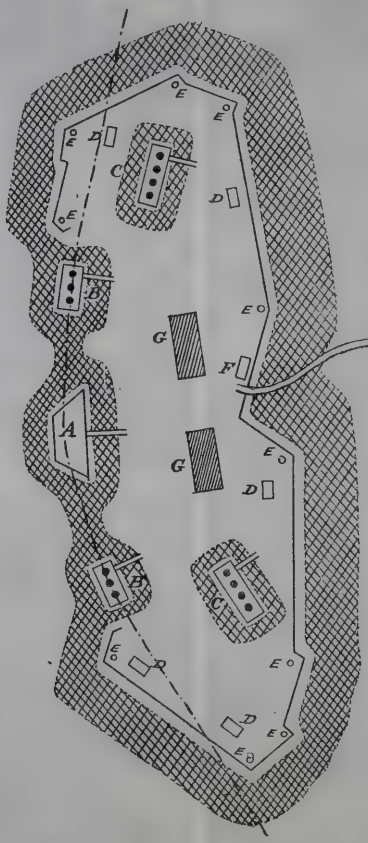
Emplacements for movable cupolas .... *E*

Defensible guardhouse .... *F*

Peace barracks .... *G*

Wire entanglement .....

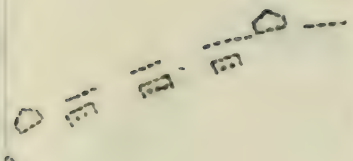
Crest of slope .....



RESS OF FORTIFICATION.

clors approximately to scale, round
Distances and dates are averaged.

nto defensive areas.
ntervals
reas.



I
Before introduction of artillery.
Walls close to town.
Up to about 1550

II
Soon after establishment of artillery
Ramparts close to town. About 1600

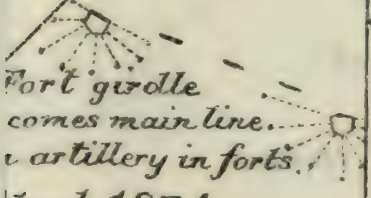
d "school.
-tillery
vals,
d or not.

-ated" school.
-tillery in forts.
generally
al only.

Works beginning to push forward. About 1800.

III

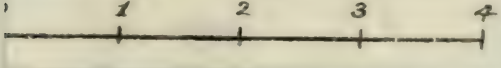
IV
Ring of forts added to enceinte which is still main line
About 1840



Fort girdle
comes main line.
artillery in forts.
bout 1874

V

proximate Scale



PROGRESS OF FORTIFICATION.

Shown in eight sectors approximately to scale, round the same kernel. Distances and dates are averaged.

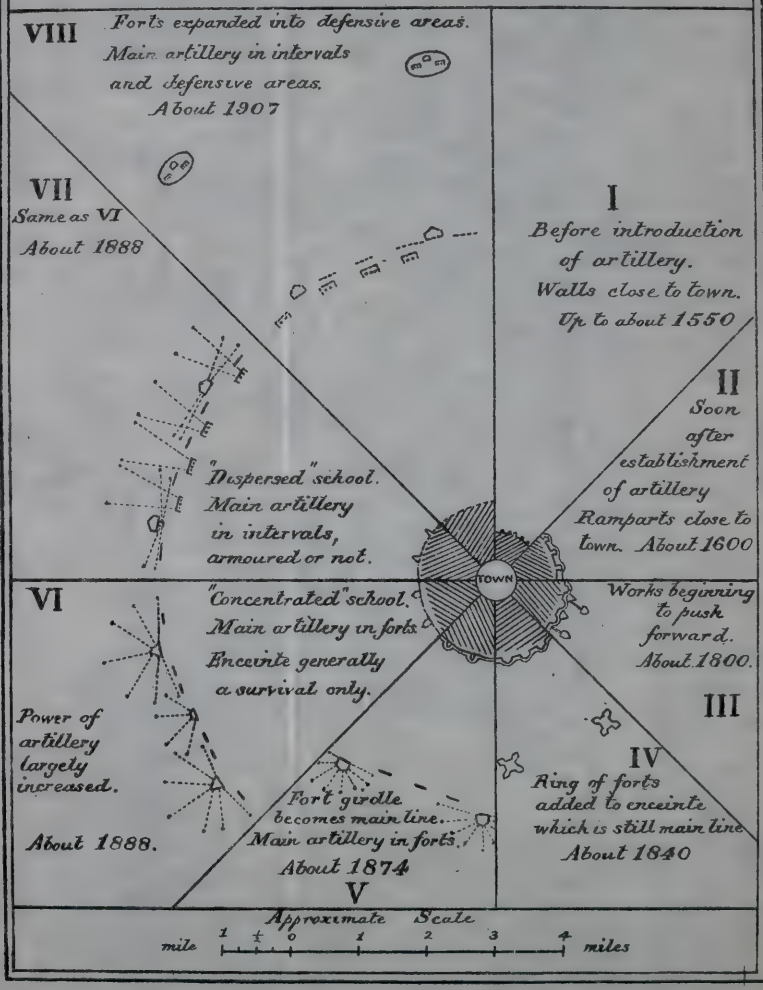
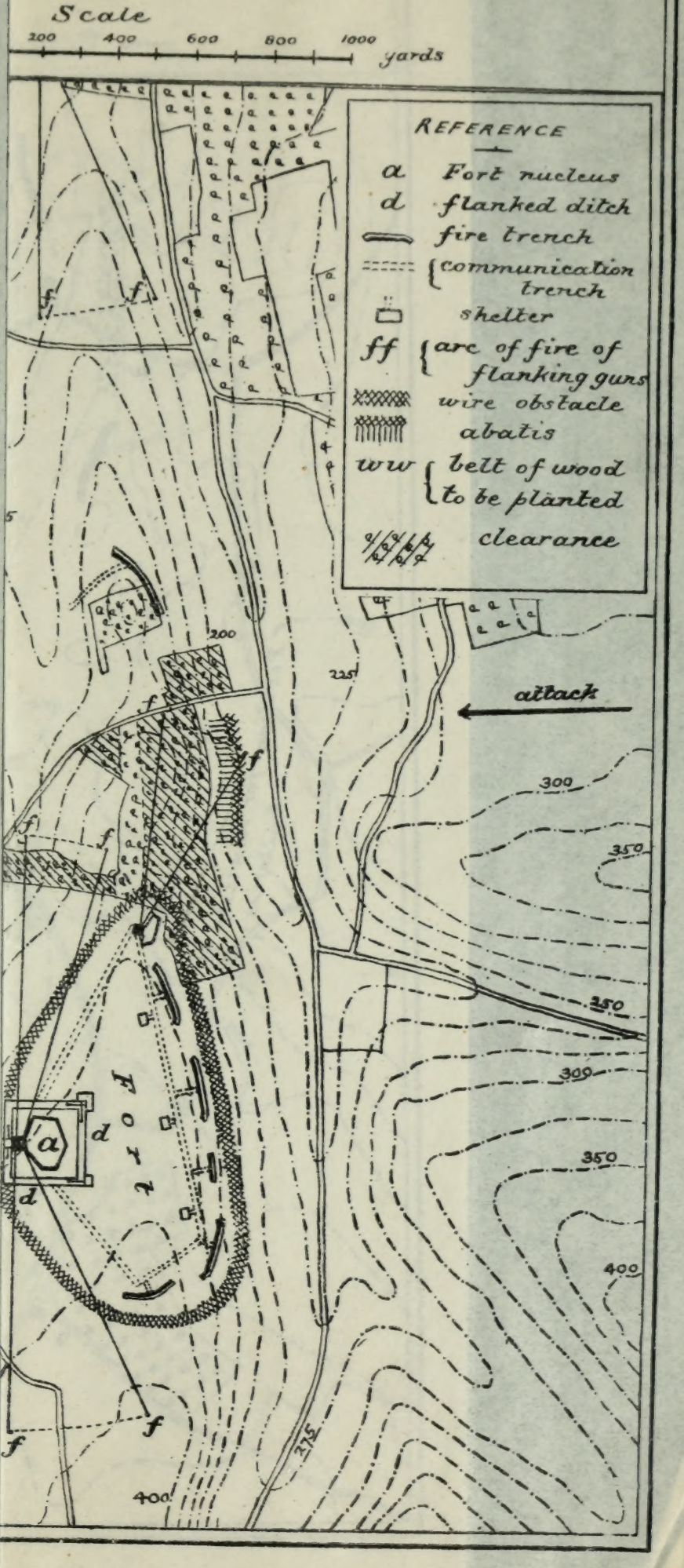

VIII
Forts expanded into defensive areas. Main artillery in intervals and defensive areas. About 1907
VII
Same as VI
About 1888
I
Before introduction of artillery. Walls close to town. Up to about 1550
II
Soon after establishment of artillery Ramparts close to town. About 1600
"Dispersed" school. Main artillery in intervals, armoured or not.
TOWN
Works beginning to push forward. About 1800.
III
VI
"Concentrated" school. Main artillery in forts. Enceinte generally a survival only.
Power of artillery largely increased.
About 1888.
IV
Ring of forts added to enceinte which is still main line
About 1840
Fort girdle becomes main line. Main artillery in forts.
About 1874
V
Approximate Scale
mile
1 ½ 0 1 2 3 4 miles

PLATE XVIII.

MODERN FORT (POINT D'APPUI).



EXAMPLE OF MODERN FORT (POINT D'APPUI).